Age and Schooling Effects on the Development of Early Literacy and Related Skills

by

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Dedication

This Thesis is dedicated to my Parents

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Acknowledgments

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Thank you everyone and I hope that you enjoy the thesis.

Anna

Declaration

I declare that the work presented in this thesis is my own work and has not been submitted for any other degree or qualification.

Note on Inclusion of Published work

Two chapters in this thesis have been accepted for publication during the period between beginning my PhD (January 2007) and my viva (August 2010). The copyright of these papers resides with the publishers. The reproduction of these papers as thesis chapters is permitted in the terms of the copyright agreement.

Chapter 2: Cunningham, A.J. & Carroll, J.M. (in press). Reading-related skills in earlier and later schooled children. *Scientific Studies of Reading*

Chapter 3: Cunningham, A.J. & Carroll, J.M. (in press). The development of early literacy in Steiner and standard educated children. *British Journal of Educational Psychology*

Chapter 6 is currently under review at the Journal of Experimental Child Psychology.

List of Terminology and Abbreviations

Age controls: Earlier-schooled age-matched control group, standard-educated 7 year olds

Earlier-schooled group: Standard-educated 4 year olds, reading controls, younger children, standard group

HLE: Home literacy environment

Later-schooled group: Steiner-educated 7 year olds, older children, Steiner group

LK: Letter knowledge

MVA: Missing values analysis

O1: Old year 1 group

OR: Old Reception group

PA: Phoneme awareness, phonemic awareness (*not* phonological awareness)

SES: Socio-economic status

T1, T2, T3, T4: Time 1, Time 2, Time 3, Time 4

Y1: Young Year 1 group

STM: Short-term memory

Abstract

There is evidence to suggest that age (natural maturation and informal experience) and schooling (formal instruction at school) have differing effects on the development of cognitive skills between the ages of 5 and 7. There is also evidence that children who start learning how to read later in childhood make faster progress than those who start earlier in childhood. However, previous studies on reading development have typically confounded age with length of schooling. The current thesis investigates the separate role of each on the development of early literacy and related skills by comparing matched groups of children differing in either exposure to formal reading instruction or chronological age. Two longitudinal studies are presented, with seven key findings.

Chapter 2 presents a cross-sectional study (n = 93) comparing a group of later-schooled 7 year olds with two control groups at the beginning of their first year of reading instruction (earlier-schooled ‘reading controls’ and earlier-schooled ‘age controls’). First, it was shown that vocabulary and short-term verbal memory skills developed with age, not schooling. Second, it was found that phoneme awareness can develop in the absence of formal reading instruction, and that this was more likely to happen in older than younger children.

Chapter 3 presents a longitudinal study (n = 61) following the progress of the first two groups from chapter 2; a group of Steiner-educated 7 years olds (later-schooled group) and a group of standard-educated 4 year olds (earlier-schooled group) during their first two years of formal literacy instruction. Results showed that the older age and superior reading-related skills of the first group did not lead to faster progress in reading, and in fact this group showed worse progress in spelling. The good progress of the earlier-schooled group was attributed to more consistent and high quality phonics instruction.

By comparing the predictors of reading and spelling in the two groups presented in chapter 3, chapter 4 showed that the skills underlying literacy development were similar in older and younger beginning readers, but that instructional emphasis on letter-sound knowledge in the earlier-schooled group reduced its power as a predictor.

Chapter 5 used mediation analyses to show that letter-sound knowledge led to phonological awareness, which in turn led to reading in the earlier-schooled children, an effect which was attributed to the method of synthetic phonics instruction administered to these children. No significant mediation was shown in the later-schooled group.

Chapter 6 presents a longitudinal study (n = 45) of the first two years of schooling in a standard school using the cut-off design. Results revealed that a dynamic measure was more effective than a static measure for measuring phoneme awareness in young children. Finally, there was an effect of both age and schooling on the development of phoneme awareness and early reading and spelling skills.

These studies demonstrate that age-related factors in addition to schooling play a significant role in the development of reading-related skills. However, although there was evidence of an age effect on literacy skills during the first year of standard schooling (chapter 6), there was only limited evidence of such an effect over a larger age range (chapter 3). In conclusion, it is suggested that concerns that age 4-5 is too early to learn to read are unfounded, and that a delay in school entry age will not necessarily lead to benefits in the acquisition of reading.

1 Literature Review

This thesis examines age and schooling effects on the development of reading and reading-related skills, with a particular focus on phonological awareness. In addition, the Steiner and standard methods of initial reading instruction are investigated.

1.1 Theories of reading development

In order to understand differences in the way that children develop from beginning to skilled readers, it is necessary to have an understanding of theories of reading development. A selection of key theories in this area is described below.

Marsh's cognitive-developmental theory is the only one that makes predictions related to age. He proposed that children progress through four stages of reading development (Marsh, Friedman, Welch, & Desberg, 1981). Entry into each stage is largely determined by the child's stage of intellectual development, as defined by Piaget (Piaget, 1985). The first stage involves linguistic guessing based on context and the second stage involves guessing based on visual and semantic cues. During the third stage, children learn to focus on a word's sounds, and are able to decode new words based on letter-sound correspondences (the 'alphabetic' phase). Entry into the third stage is stimulated by progression to Piaget's stage of concrete operations (usually occurring at the age of 7). Lastly, children enter the stage of hierarchical decoding. Here, they are able to use higher order rules and analogies to decipher new words; a stage which requires the child to have entered the formal operation stage (usually occurring at the age of 11).

Frith’s theory (1985) differs from that of Marsh in the sense that the first two stages are amalgamated into one ‘logographic’ stage. Frith proposed that children move through three distinct ‘phases’ when learning to read and spell. First is a logographic phase when children recognise words based on distinct contextual or visual cues e.g., their name. Second is the alphabetic phase where children are able to decode based on grapheme-phoneme correspondences. Finally, in the orthographic phase, words can be recognised on the basis of longer sequences of letters, particularly morphemic units. Frith also discussed the development of spelling which has a later logographic and longer alphabetic stage.

Seymour (1990) rejected the idea of a distinct logographic phase that preceded alphabetic decoding. In his dual-foundation model of early literacy, he proposed that first children learn grapheme-phoneme correspondences, then, in no particular order they develop the dual foundations of logographic and alphabetic processes. Logographic processes refer to whole word recognition while alphabetic processes refer to sequential decoding based on grapheme-phoneme correspondences. Lastly, children progress to the orthographic phase where they are able to read fluently based almost entirely on stored orthographic information (Duncan & Seymour, 2000).

Stuart and Coltheart, (1988) argue against a ‘stage’ theory of reading development which states that all children pass through the same stages at the same time. Instead, they suggest that children who have good phonological awareness and letter-sound knowledge at the start of school read ‘alphabetically’ from the beginning, while children who are not phonologically skilled at this time start reading in a visual way (akin to a ‘logographic’ stage). However, they ‘catch-up’ and start reading alphabetically at a later time when they have developed sufficient letter-sound knowledge and phoneme awareness. According to this theory, there is an early phase during which children form partial representations of words based on their beginning and end letters. Then, there is a later phase when children who have developed sufficient knowledge of vowel spellings form more complete representations of words in sight memory.

A key component of all the above theories is that children must acquire an understanding of the alphabetic principle (that letter sequences correspond to sounds) before they are able to become fluent readers (Ehri, 2007). In an attempt to bring together the commonalities between different theories, Ehri developed her four-phase theory of sight word reading (Ehri, 1998, 1999). Each phase is defined by the principal way in which written words are connected to their other identities in memory. During the pre-alphabetic stage, words are identified through visual and contextual connections. Next, during the partial alphabetic phase, words are characterised by their most salient letters and sounds. Then, during the full alphabetic phase, there is complete connection between graphemes and phonemes, allowing whole words to be decoded at the level of the phoneme. Finally, in the consolidated alphabetic stage, connections are formed between the spelling and pronunciation of more complex syllabic and morphemic units.

Some predictions with respect to the role of age on reading development can be made on the basis of Marsh's theory. This theory predicts that children learning to read before the age of 7 will not have the intellectual maturity to enter the alphabetic stage immediately, whereas older children who are above the age of 7 when they start school will have the capacity to do so and therefore may develop initial reading more quickly. With regard to the role of schooling, no clear predictions can be made on the basis of existing theories, as they generally assume that all children develop reading in the same way and do not discuss instruction. The current thesis contributes to future theories by investigating more completely the role of age and schooling on the development of reading.

1.2 Phonological awareness

In order to enter the ‘alphabetic’ stage of reading development, a child must first become aware that words comprise of separable sounds (Ehri, 2007). This is known as phonological awareness. Phonological awareness is defined as ‘the ability to recognize the internal sound structure of spoken words’(Bentin, Hammer, & Cahan, 1991, p. 271). Words are typically broken into three different levels of phonological unit; at the smallest level there are phonemes, which are denoted by individual letters or digraphs e.g. /b/. At the next level there are onsets and rimes which refer to the initial phoneme/s and final part of a word e.g., *cat* is made up of the onset ‘*c*’ and the rime ‘*at*’. Finally, some words can be divided into syllables which are the largest unit of speech e.g., ‘pump’ and ‘kin’ in ‘pumpkin’

It makes sense that the ability to identify and manipulate sounds would facilitate the acquisition of reading. For this reason, a large body of research has identified phonological awareness as one of the most important influences on the acquisition of early reading ability (Goswami & Bryant, 1990).

Awareness of the smallest units (phonemes) has been shown to be the variable most strongly associated with early reading and spelling ability. For example, early readers with good phoneme awareness (PA) tend to make better progress in reading than those with poor awareness (e.g., Hulme, et al., 2002; Muter, Hulme, Snowling, &

Stevenson, 2004; Muter & Snowling, 1998). In addition, training in phoneme awareness has been shown to improve reading both immediately following (Hindson, et al., 2005), and several years after the training is given (Byrne, Fielding-Barnsley, & Ashley, 2000). There is also a great deal of research which shows that onset/rime awareness contributes significant unique variance to the prediction of reading and spelling skills (Bowey & Francis, 1991; Bryant, 1998; Goswami & Bryant, 1990). However, there are many studies which show that rime awareness contributes no additional variance to the prediction of reading and spelling once the effects of phoneme awareness had been partialled out (Duncan, Seymour, & Hill, 1997; Hulme, et al., 2002; Muter, Hulme, Snowling, & Taylor, 1997). In conclusion, it is generally accepted that the ability to perceive and manipulate phonemes is the aspect of phonological awareness that is most strongly predictive of later success in reading and spelling (Castles & Coltheart, 2004).

1.2.1 *The development of phonological awareness*

Goswami and Bryant (1990) proposed that children progress through different levels of phonological awareness from awareness of syllables to awareness of onsets and rimes to awareness of phonemes. Subsequent research suggests that this theory can be simplified to progression from awareness of large units (syllables and rimes) to awareness of small units (phonemes) (Carroll, Snowling, Hulme, & Stevenson, 2003).

Alternatively, Gombert's (1992) theory of phonological development suggests that children move from having an implicit 'epilinguistic' knowledge of sounds to an explicit 'metalinguistic' knowledge. At the epilinguistic stage, children's understanding of sounds is based on experience of everyday words and they solve phonological tasks based on global similarity between words. At the metalinguistic stage, children become consciously aware of the sounds in words and start to understand how they can be manipulated. In other words, epilinguistic awareness is implicit while metalinguistic awareness is explicit. To illustrate, a child at the epilinguistic stage may be able to detect and match phonological units based on sound similarity but would need to be meta-linguistically aware to add or delete the same units. Gombert's theory is consistent with the results of Carroll et al. (2003) who showed that infants were able to solve matching tasks before deletion tasks.

Gombert proposes that metalinguistic awareness typically develops at the age of 6 or 7. Notably, this age is universally acknowledged as an important time of transition in the development of language. For example, Boutet, Gathier and Saint-Pierre, (1983, p. 91) said 'it is at this age that we observe the passage from a use of language based exclusively on experiences of reality to a possibility of apprehending linguistic objects in a metalinguistic way'. The conclusion is that 6-7 is the 'natural' age at which to develop metalinguistic skills. However, Gombert's interpretation is based on studies of children who began learning how to read at about 5 years old. For example, he cites research that found that most 6-7 year olds could delete initial syllables, while only a small percentage of 3-4 year olds could do this (Content, 1984, 1985). Given that learning how to read enhances phonological awareness (e.g., Perfetti, Beck, Bell, & Hughes, 1987), it is possible that these findings are due to the fact that the 6-7 year olds had experienced formal reading instruction rather than any kind of spontaneous developmental change.

An alternative theory is proposed by Seymour (1990) in his model of Foundation literacy. According to this model, explicit awareness of small units (phonemes) develops before explicit awareness of large units (rimes). Evidence for this theory is provided by Duncan and Seymour (2000) who found that children with a reading age below 7 years (foundation readers) could isolate the onset (initial phoneme) of words, but not the rime while children with a reading age of 7-8 years (orthographic readers) could isolate the onset and the rime. Also, Duncan, Seymour and Hill (1997) found that beginning readers used their knowledge of letter sounds (at the phoneme level) to decode non-words rather than by making analogies with familiar rime units.

1.3 The measurement of phonological awareness

Phonological awareness is measured by testing a child's ability to recognise and manipulate phonological units. Researchers have used a variety of different tasks to measure phonological awareness which can cause confusion in the interpretation of findings. Evidence for the fact that different tasks tap different abilities come from the finding that phonological awareness consists of anywhere between one (Anthony & Lonigan, 2004; Stanovich, Cunningham, & Cramer, 1984), two (Muter, Hulme, Snowling, et al., 1997) and four (Wagner, Torgesen, Laughon, Simmons, & Rashotte, 1993) 'factors', depending on which tasks are used to measure it. For example, substitution, deletion, completion, matching, oddity and blending tasks have all been used to measure phoneme awareness, yet all tap slightly different skills and are appropriate for children at different stages of development. Findings from different tasks are then compared to reach conclusions about phonological awareness, frequently without due reference to the nature of the tasks used (Bryant, 1998).

Failure to control for global phonological similarity across stimuli in forced choice tasks has further confused the validity of findings (Carroll & Snowling, 2001). If global similarity is not controlled, matching and oddity tasks can be solved using epilinguistic processes alone. Children can ‘match’ two rhyming words on the basis that they are overall more similar to each other than to the distracter. If the distracter is equally similar to the target as the correct response, then children must segment at the level of the rime, thereby more accurately reflecting rime awareness. In addition, care must be taken if using real words as stimuli e.g., ‘bold’ without the ‘b’ is ‘old’. In this case, children may recognise one word within the other and pronounce this as the response because it is meaningful to them, not because they have actually deleted the phoneme.

Another difficulty is that children with existing literacy skills may use orthographic knowledge to help solve phonological tasks. For example, if they know how to spell ‘bus’, when asked to delete ‘b’, they may do this visually in their heads and produce ‘us’ as the remaining segment. If this were the case, then no actual *phonological* skills are used in solving the task and any association between scores on ‘phonological awareness’ tasks and reading ability may be entirely due to orthographic skills (Castles & Coltheart, 2004). For example, Castles, Holmes, Neath and Kinoshita (2003) discovered that children in grade 5 (10-11 year olds) found it easier to delete phonemes from items where there was a direct correspondence between the sound to be deleted and the letter representing it (e.g., take the /rə/ from ‘struggle) than where there was not (e.g., take the /wə/ from ‘squabble’). This implied that they were using orthographic information to help solve phoneme awareness tasks. The only way to avoid this problem is to test children who have no orthographic skills (letter knowledge or reading). As most 3 year olds in the UK know at least a few letters, this is a very difficult sample to attain.

Hulme et al., (2002) attempted to address the issue of task variability by testing 5-6 year old children on three different types of task (deletion, oddity and detection) using four different 'levels' of phonological unit (initial and final phoneme, onset, and rime). The same non-words (to minimise reference to existing orthographic information) were used in each task. The authors found that the predictive power of onset-rime tasks on subsequent reading became insignificant after the effects of the phoneme tasks were partialled out. Ability to identify the initial phoneme contributed the most unique variance (10%) once the effects of age, verbal ability, and the other phonological tasks were partialled out. A comparison of mean levels of performance revealed that children found the detection tasks easiest and the deletion tasks hardest. Within task types, children performed better on the onset and rime tasks than on the initial and final phoneme tasks (with the exception of final phoneme deletion which was the easiest deletion task). These findings are consistent with the theory that children move from an 'epilinguistic' knowledge of large segments to a 'metalinguistic' awareness of small segments (Gombert, 1992). To conclude, if you want to predict early reading, then it is best to test phoneme awareness, in particular initial phoneme deletion, using non-words.

1.3.1.1 *Phonological learning*

There is evidence to suggest that measures of phonological learning (the ease with which a child acquires phonological skills) are more powerful predictors of early literacy development than static measures of phonological awareness. A study by Hindson, Byrne, Fielding-Barnsley, Newman, Hine and Shankweiler (2005) looked at the responsiveness of two groups of preschool children to the 'Sound foundation' phoneme identity training program developed by Byrne and Fielding-Barnsley (1991).

One group was at familial risk for reading disability and one group was without familial risk. The phoneme awareness of the non-risk group improved slightly more than the at-risk group in response to the training. They also required less teaching sessions to reach criterion (success in learning the phoneme). Hierarchical multiple regressions showed that progress during training (number of teaching sessions to reach criterion) contributed unique variance above and beyond post intervention scores on PA in non-word reading and spelling one year later. Number of sessions needed to learn a phoneme can be considered an index of phonological learning.

Byrne, Fielding-Barnsley and Ashley (2000) conducted a follow-up study six years after training a group of over 60 children how to identify phonemes using their ‘sound foundations’ program. Their results revealed a similar pattern whereby rate of progress during initial training predicted gains in reading and spelling six years later in addition to that accounted for by the actual level of phoneme awareness achieved post-intervention. The authors argued that ‘learning’ measures (such as progress on phoneme identity training), could be just as, if not more important as static measures in predicting early literacy skills.

It is not necessary to conduct an intervention study to measure phonological learning. An alternative is to administer a dynamic task. In a longitudinal study of 38 Kindergartners, Spector (1992) discovered that a dynamic test of phoneme segmentation predicted end of year phoneme segmentation, word recognition and spelling substantially better than a static measure using similar items. During the task, children were given increasingly explicit prompts to help them segment words. A ‘learning’ score was calculated by totalling how may prompts the child needed before they were able to successfully segment each word.

Despite general support for the value of a dynamic measure of PA, there have been instances where it has failed to add predictive value. A new test of phonological learning developed by Samuelsson et al. (2005) was trialed on a large number of 4-5 year old twins. The test consisted of an adapted version of Byrne et al.'s (1991) phoneme matching task whereby children were given increasingly explicit prompts to help them match pictures on the basis of their initial or final consonant. Unfortunately, it did not contribute any additional variance to the prediction of a range of prereading skills above a static measure. One suggestion was that the measure may not have been sensitive enough to differ reliably from a static measure as a large number of children scored at floor or ceiling level. It was therefore probably more reflective of a child's current phonological knowledge rather than their learning potential. In conclusion, care must be taken to design a dynamic measure that is suitable for the age and skill level of the target sample.

1.3.2 *Phoneme awareness: A precondition or consequence of reading?*

In describing the relationship between phoneme awareness and reading, there are three possibilities. First, that reading causes phoneme awareness, second, that phoneme awareness plays a causal role in reading, and three, that there is a reciprocal relationship between the two. Below is a summary of relevant research in support of each theory.

1.3.2.1 *Studies of alphabetically illiterate adults and children*

Studies of adult illiterates suggest that phoneme awareness develops as a consequence of learning to read and write in an alphabetic script (reading causes phoneme awareness). Morais, Cary, Alegria and Bertelson (1979) found that illiterate adults recruited from an agricultural area of Portugal generally could not delete or add initial phonemes from spoken non-words (average accuracy 19%) while adults from a similar background who had learnt to read later in life could perform these tasks with relative ease (average accuracy 73%). The conclusion was that phoneme awareness does not develop naturally, but rather is dependent on literacy instruction.

One criticism of this study was that the impaired performance of the illiterates may not be specific to reading instruction and could be due to differences in general ability or reflect misunderstanding of the task (Koopmans, 1987). To address these concerns, a further study compared similar adults on a wider range of tasks. It was found that the illiterates performed at a similar level to ex-illiterates on a melody segmentation task but that their ability to delete initial phonemes was significantly poorer. Illiterates were able to perform successfully on tasks of syllable and rime segmentation, although their performance was still inferior to that of the ex-illiterates (Morais, Bertelson, Cary, & Alegria, 1986). These findings suggest that task interpretation or motivation was not a particular issue in this experiment.

Another limitation highlighted by Koopmans (1987) was that superior performance of the ex illiterates may be due to general effects of schooling rather than literacy instruction. In their defence, Bertelson, Morais, Cary and Alegria (1987) refer to a study by Read, Zhang, Nie and Ding (1986). Chinese adults who were literate only in

Chinese characters (logographic script) were compared to a group of younger adults who were also literate in an alphabetic script. It was found that only the group who knew an alphabetic script could perform competently on tasks of phoneme segmentation. This difference occurred despite similar exposure to formal schooling. Further evidence in favour of Morais et al. (1979), comes from a study by Mann (1986) which showed that Japanese first graders instructed in a non-alphabetic (syllabary) script could not count and delete phonemes while American first graders could.

1.3.2.2 *Training studies*

In contrast to work on illiterates, training studies suggest the opposite pattern; that phoneme awareness plays a causal role in reading. Castles and Coltheart (2004) performed a review of relevant studies in an attempt to establish whether such a causal link existed. They concluded that although studies to date generally support this theory, no study as yet has provided unequivocal evidence for it because they have all failed to meet the strict criteria for demonstrating causality. Nevertheless, a large number of studies were cited in support of a causal connection.

A condition of demonstrating causality is to show that training in the causal skill leads to specific gains in the outcome. Training studies have consistently shown that pre-readers can be successfully trained in phoneme awareness and that the resulting improvements in PA go on to predict subsequent reading ability (Castles & Coltheart, 2004). Programs that combine instruction on the manipulation of sounds with alphabetic information generally have a greater impact on reading than those which focus only on sounds (Bradley & Bryant, 1983; Bus & van IJzendoorn, 1999; Hatcher, Hulme, & Ellis, 1994). For example, Hatcher, Hulme and Ellis (1994) compared three different kinds of intervention to improve early reading failure and compared them to untrained controls. One group of 7 year olds with poor reading received training in reading and phonology, one in reading alone and one in phonology alone. Although the phonology alone group improved most on tasks of phonological awareness, there was no significant transfer of their skills to reading. The reading with phonology group was the only group that made significantly more progress in reading and spelling than controls. Furthermore, these gains were sustained at a nine month follow-up. The theory that associating phonological with orthographic skills will enhance reading more than phonological skills alone is called the ‘phonological linkage’ hypothesis (Hatcher, et al., 1994).

Similar findings came from a study by Bradley and Bryant (1983) who looked at the effects of phoneme awareness training in four groups of pre-schoolers. Group 1 was given intensive training on phoneme segmentation over a period of two years while group 2 was given the same but with an added focus on how sounds are related to letters. Group 3 was taught how to categorize the words conceptually and group 4 received no training at all. Results showed that even when the effects of age and IQ were co-varied, groups 1 and 2 outperformed groups 3 and 4 on tests of reading and spelling at the end of the two years. Group 2 performed significantly better than group 1 on spelling but not on reading. This shows that phonological linkage may be more important to spelling than to reading. Notably, the positive effect of training was specific to literacy as a test of mathematics showed differences between the groups that were a great deal smaller.

It could be argued that through exposure to letters, phonological linkage involves an element of reading instruction. In defence of the theory that phoneme awareness can precede reading, there are a few training studies that have shown beneficial effects on reading of phonological training in isolation. For example, Cunningham (1990) found that training in phonology could be effective in the absence of relation to letters if children were shown how to use segmentation and blending skills in a reading context e.g., they were told that a good strategy to use to decipher a new word is to 'cut the word up'. The author found that this 'meta level' approach to phonemic training was more influential on subsequent reading than the 'skill and drill' approach of teaching the skills in isolation. Similar results were discovered by Lundberg and colleagues (1988) in a longitudinal study of 235 Danish pre-schoolers. Children were given explicit training in phoneme awareness (in the absence of orthographic information) over a period of 8 months. Reading and spelling tests taken 2 years later revealed that the experimental group performed significantly better than untrained controls. Furthermore, the differences did not extend to vocabulary or Mathematics, suggesting that the positive effect was specific to literacy.

1.3.2.3 *Longitudinal studies*

It is intuitive that the ability to identify and manipulate small units of sound both *aids in* and *develops with* the process of learning how to read. This is known as a reciprocal relationship, a theory that is supported by a number of longitudinal studies. Longitudinal studies show that phoneme awareness at the onset of reading instruction predicts later reading, and that learning how to read causes a large increase in phoneme awareness skills during the first year of school. For example, Perfetti, Beck, Bell and

Hughes (1987) followed children at four times points during their first year of reading development. Phoneme deletion ability at the start of the year was a strong predictor of reading at the end of the year. Using cross-lagged partial correlations, they found that improvement in reading led to improvement in phoneme deletion, which in turn led to further improvement in reading. Interesting, results from the phoneme blending task showed a more unidirectional relationship, that phoneme blending led to reading. By the end of the year, both skills were almost at ceiling.

Wimmer, Landerl, Linortner and Hummer (1991) conducted a study of 6-7 year old Austrian children during their first year of learning how to read. They found that non-readers at the beginning of the year demonstrated little or no phoneme awareness but performed well on PA tasks after only a few months of reading instruction. However, despite low levels, phoneme awareness at the beginning of year was a strong predictor of reading at the end of the year. In a similar vein, a reciprocal relationship between letter knowledge and phoneme awareness has been demonstrated in a study of American pre-readers (Burgess & Lonigan, 1998). Letter knowledge at Time 1 predicted variance in phoneme awareness at Time 2. In turn, phoneme awareness at Time 1 predicted letter knowledge at T2. These results suggest a relationship between phoneme awareness and letter knowledge in pre-schoolers not unlike the one discovered between phoneme awareness and reading in school-age children.

1.4 Additional predictors of reading

Reading is a highly complex skill which has many causes and influences (Nation, 2008). Even though phonological awareness is the predictor that has received the most attention from recent research, there are other significant predictors of reading that have an important effect during the first years of school (Muter, et al., 2004; Nation & Snowling, 2004). A selection of key variables in this area and their relationship with reading is described below.

1.4.1 *Letter knowledge*

Letter knowledge has a strong relationship with early literacy ability. In general, the more letters a child knows at the beginning of school, the better their reading (Duncan & Seymour, 2000; Lonigan, Burgess, & Anthony, 2000; Muter, et al., 2004), and spelling skills (Muter, Hulme, Snowling, et al., 1997) one and two years later. Letter knowledge is usually complete before the end of the first year at school (e.g., Seymourr et al., 2003), therefore its value as a predictor is only relevant during the early stages of reading development.

Letter knowledge is not a unitary construct; it consists of two components: letter-name knowledge and letter-sound knowledge. Which one a child acquires first depends on the method of instruction. For example, in the US, children are traditionally taught letter names first whereas in the UK, the emphasis is on letter sounds (Ellefson, Treiman, & Kessler, 2009). In instances where letter names are learnt first, research has shown that children can use their knowledge of letter names to help them learn letter sounds. The ‘sound facilitation hypothesis’ makes the claim that when a letter name begins with the sound e.g. /b/, then the sound is learnt more easily than if it is unrelated e.g. /w/, or if the sound is at the end e.g. /l/ (Treiman, Weatherston, & Berch, 1994). Research has shown that letter-sound and letter-name knowledge are strongly associated in beginning readers (e.g., Lonigan, et al., 2000) and that both are important predictors of early literacy development (McBride-Chang, 1999; Treiman, 2006).

According to the ‘alphabetic principle’, as described by Byrne (1998), letter-sound knowledge and phoneme awareness are the two foundations of literacy development. The theory is that children cannot acquire reading and spelling until they have understood that letter symbols map onto sounds. Therefore, both skills are essential in the acquisition of reading and spelling. This theory would explain the importance of letter-sound knowledge as a predictor, but not letter-name knowledge. It may be that letter-name knowledge has a similar effect to letter-sound knowledge via their close association (Treiman, et al., 1994) and the similarity between letter names and certain phonemic units e.g., ‘ee’.

1.4.2 *Oral language skills*

It is important to look at reading development within the context of a broader language system (Hulme, Snowling, Caravolas, & Carroll, 2005). Reading is about more than just decoding skills; children must be able to understand what they read for the process to be worthwhile. They must also be able to read individual words before they can understand whole sentences, leading to a strong association between word recognition and reading comprehension during the early years of schooling (e.g., Storch & Whitehurst, 2002). Some studies have shown that oral language skills predict both reading comprehension and word recognition while other studies show that they are unique predictors of reading comprehension only. For example, Nation and Snowling (2004) found that vocabulary, listening comprehension and semantic skills in 8 year olds predicted unique variance in reading comprehension and word recognition ability four years later. In addition, Wagner et al., (1997) found that vocabulary in 1st Grade was a significant predictor of word reading in third grade.

On the other hand, Muter et al., (2004) found that vocabulary and grammatical skills were significant predictors of reading comprehension, but not word recognition during the first year at school. The authors suggested that oral language skills were likely to become more important as facilitators of word recognition later in development as the range of words encountered during reading became more complex. In contrast to their theory, Storch and Whitehurst (2002) showed that oral language skills including vocabulary and conceptual knowledge predicted reading comprehension, but not word reading from early to late elementary school. Also, a study of Greek children found that grammar (memory for sentences and sentence assembly) was neither a concurrent or longitudinal predictor of word reading or spelling in 7-10 year olds (Nikolopoulos, Goulandris, Hulme, & Snowling, 2006). In conclusion, it is likely that the relationship between oral language skills and reading is complex, and that it does not necessarily change with age in a predictable fashion.

1.4.3 *Short-term verbal memory*

Short-term verbal memory (verbal STM) is defined as the ability to retain phonological information in short-term memory. Verbal STM is important because when a child decodes a word, they must temporarily store that word in memory. Consequently, it has been linked by a number of studies to early reading ability. For example, Muter and Snowling (1998) found that nonword repetition (ability to repeat a nonword spoken by the experimenter) measured at ages 5 and 6 predicted reading skills at age 9 in a group of 34 primary school children. Additionally, Gathercole, Willis, Emslie and Baddeley (1992) found that two measures of verbal STM (nonword repetition and digit span) correlated strongly with reading in children between the ages of 4 and 8. Memory for sentences is a way of measuring the ability to remember longer sequences of information, and has also been linked to reading. For example, Wagner, Torgesen and Rashotte (1994) found significant correlations between the ability to repeat the last word in spoken sentences and word reading in 5 - 8 year olds.

1.4.4 *Visual-verbal learning*

Windfuhr and Snowling, (2001) found that visual-verbal paired associate learning (the ability to learn to associate a visual with a verbal stimulus) accounted for 16% of unique variance in reading among 7-11 year olds once the effect of age, IQ and vocabulary had been partialled out. Subsequent research showed that visual-verbal learning predicted word and irregular word reading (but not non-word reading) after controlling for phoneme deletion skills (Hulme, Goetz, Gooch, Adams, & Snowling, 2007). It is suggested that visual-verbal learning tasks predict reading because they echo the process of mapping visual onto phonological information when learning to read new words. This skill is also potentially important when learning to associate letter symbols with their corresponding sounds.

1.4.5 *Socio economic status*

Environmental factors such as socio-economic status (SES) and home literacy environment (HLE) have been shown to account for differences in pre-literacy and literacy skills during early childhood. Socio economic status is an index of ‘social class’ and can be measured by any number of variables including income, employment status, free lunch eligibility, house or car ownership and parental education level (Duncan & Seymour, 2000). Maternal education level is a particularly good indictor of SES as it shares some of the highest correlations with other indices of social class (Caughy, Dipietro, & Strobino, 1994).

Socio economic status seems to have a strong effect on reading with children from poorer backgrounds far more likely to achieve low scores on primary level reading tests than children from middle class backgrounds (e.g., Raz & Bryant, 1990). Duncan and Seymour (2000) compared the letter knowledge, word and non-word reading of a group of primary school children from a high SES area of Scotland with a group of children from a relatively low SES area. They found that the low SES group developed foundation literacy skills at a slower rate than the high SES group. However, the pattern of development was similar in both groups implying that the poorer children developed 'later' rather than differently from their more affluent counterparts. Bowey (1995) found similar results with regard to reading achievement and phonological awareness in a groups of high vs. low SES Australian first graders. In this case, there was evidence that socioeconomic status differences in first grade word reading were mediated by pre-existing differences in phonological sensitivity during Kindergarten.

1.4.6 *Home Literacy environment*

Home literacy environment is comprised of factors such as frequency of shared book reading, number of children's books in the home and frequency of parents' private reading. In a meta-analysis, Bus, Van Ijzendoorn and Pellegrini, (1995) showed that frequency of shared book reading between parent and pre-schooler accounted for 8% of variance in language growth, emergent literacy and reading achievement. Importantly, these effects were independent of socioeconomic status. Similar results were reported by Burgess, Hecht and Lonigan (2002) and Griffin and Morrison (1997) who found that social class measures did not contribute unique variance above and beyond HLE in the prediction of early language and reading skills. In line with these findings, Christian, Morrison and Bryant (1998) found that mothers from poorer backgrounds could ‘protect’ against the adverse effects of low SES on the academic achievement of their child in Kindergarten by providing a good HLE. However, highly educated mothers were more likely to provide a rich home literacy environment, suggesting that HLE may mediate the link between SES and reading.

In a large scale study of over 1000 pre-school twins, Samuleson and Byrne et al., (2005) found that measures of HLE (such as shared book reading, letter based activities, print motivation, and parent reading behaviour) correlated to varying degrees with pre-reading skills such as general verbal ability, phonological awareness and print knowledge. The strongest unique predictor of pre-reading skills was shared book reading which accounted for 19% of the variance in print knowledge. Adding the other variables accounted for only 2% of additional variance leading to the conclusion that shared book reading was the most important aspect of home literacy in relation to early reading.

1.5 Age and schooling effects on reading-related skills

It is generally recognized that the first few years of school are characterized by large changes in children’s cognitive functioning. Together, these changes have been referred to as the ‘5-7 shift’ (Morrison, Griffith, & Frazier, 1996). On a cognitive level, children’s thinking is recognized as being more logical and abstract (Piaget, 1985), memory improves with the increased use of rehearsal and organizational strategies (Bjorklund, 1987) and meta cognitive skills develop such that children start to become aware of their own learning (Gombert, 1992). Schooling, in particular, has been highlighted as a significant influence on cognitive growth. Cross cultural research has revealed large differences between schooled and unschooled children in the development of perceptual and memory skills, logical reasoning and concept development (Rogoff, 1981). In this thesis we are concerned with the '5-7 shift' in skills directly related to reading.

Re-analysis of data from previous studies shows that there is a large difference in scores on measures of reading-related skills between children at opposite ends of the '5-7' shift. For example, mean comparisons on data from a study by Gathercole, Willis, Emslie and Baddeley (1992) showed a significant difference between 5½ year old and 8½ year old children on tests of phonological memory ($t = 4.25$, $p < 0.1$) and vocabulary ($t = 9.82$, $p < .01$). In addition, data from Wagner, Torgesen and Rashotte (1994) showed that there were significant differences between 5½ year olds and 7½ year olds on measures of sentence memory ($t = 13.40$, $p < .01$), vocabulary ($t = 12.50$, $p < .01$) and phoneme deletion ($t = 22.95$, $p < .01$)[1].

These findings suggest that a significant developmental change occurs between the ages of 4 and 8 in skills that relate to a child's ability to read. However, in these studies, age is confounded with length of schooling. Therefore, it is not evident how much of the changes may be due to increased reading experience (schooling effects) and how much due to 'natural' developmental processes (age effects). In the current thesis, age effects refer to the influence of natural cognitive maturation and informal experience on development, whereas schooling effects refer to the influence of formal instruction.

[1] Thank you to Carol Rashotte for providing this data, July 2007

1.5.1 *The cut-off method*

One way of avoiding the confounding effects of schooling and age is to use the cut-off method. Morrison, Smith and Dow-Ehrensberager, (1995) used the natural school 'cut-off' date to study the oldest and youngest children in the same year group (usually those born within 2 months of the cut off date). For example, in England, those born in July and August would be the youngest and those born in September and October would be the oldest in a year group. Using this method he was able to measure age effects by comparing children who were up to 12 months (and on average 10 months) different in age but who had received the same amount of schooling. Schooling effects could be measured by comparing the oldest children in one year group with the youngest children in the year above, so that they are roughly matched for age but differ by one year of schooling. Examination of both effects is possible with two age-matched groups if measures are repeated one year later in a longitudinal design. To ensure good comparability, groups are usually matched on background variables such as IQ, SES and pre-school experience.

The overriding consensus of studies that have used this method is that the relative contributions of age and schooling vary greatly between domains and even sub-domains of cognitive skills (Morrison, et al., 1996). As expected, skills that are directly taught at school such as reading and Mathematics demonstrate powerful schooling effects, while more generic skills such as vocabulary, general knowledge and narrative skills exhibit greater age-related effects (Christian, Bachnan, & Morrison, 2001). Below is a summary of research on the effect of age and schooling on skills directly related to reading.

1.5.2 *Phonological awareness*

In the study by Morrison et al., (1995), ten older Kindergarteners and ten younger Grade One children were compared on measures of phonological segmentation every year for two years. Both groups exhibited similar start levels and progress over the two years in the subsyllabic segmentation task (onset-rimes). In addition, the majority of children from both years scored highly on the syllabic segmentation task at the first time point indicating that this skill developed during pre-school and was not reliant on reading instruction. The conclusion was that age was the major determinant in the development of large segment awareness. Age interacted with schooling on the phonemic segmentation task during the Kindergarten year with the older children for the year group improving significantly more in this skill than their younger counterparts during the same year. However, this interaction did not persist in first grade (the first year of formal reading instruction), during which time there was no significant difference in the progress made by each group. The authors concluded that once formal reading instruction began, its effect was so strong as to supersede the age effect.

A study by Christian, Morrison, Frazier and Massetti, (2000) which employed the cut-off method with the same age group found similar results. There was no effect of schooling on phonemic segmentation skills during the Kindergarten year but a large effect during First grade to coincide with the onset of reading instruction. The authors also found no significant effect of schooling in either year on subsyllabic segmentation.

Another study by Bowey and Francis (1991) measured age and schooling effects on three levels of phonological awareness using a three group cut-off design. The oldest children in Kindergarten (age 5;5) were compared with the youngest children in first grade (age 5;8) who were, in turn compared with the oldest children in first grade (age 6;4) (n = 20 per group). The first two groups (OK and Y1) had equivalent vocabulary scores while the O1 group had a more advanced vocabulary (although all three groups had similar standardised scores). The OK group was screened for initial reading ability and only those children who could not recognise any words were selected for the study while the two First grade groups both had some reading. Based on the Bradley and Bryant (1983) study, the authors devised a series of six phonological oddity tasks to assess sensitivity to onsets and rimes, and (making sure to separate them from onsets) phonemes.

The results showed that, in accordance with previous research showing that phoneme awareness develops in conjunction with reading (e.g., Perfetti, et al., 1987; Wimmer, et al., 1991); the performance of the OK group was significantly poorer than the Y1 group on the tasks requiring analysis at the phonemic level. In addition, differences in the same direction occurred for the onset/rime tasks. All groups found the phonemic analysis tasks the hardest, particularly the OK group who could not yet read. Not a single OK child performed above chance on either of the tasks which required phonemic analysis and there were no significant differences in performance between the two first grade groups, who allegedly had similar levels of reading ability (although results of the reading tests were not reported in the paper). However, there were mean differences consistently in favour of the older first graders, suggesting the existence of an age effect had power been greater.

Further evidence for the robust effect of reading instruction on phonemic skills during the first year of instruction comes from a study by Bentin, Hammer and Cahan

(1991) which looked at over 300 Kindergarten and first grade children. To increase power, all children within each year group were tested, regardless of birth date. At time of testing, the first grade children had experienced 5 months of reading instruction, while the Kindergarteners had had no formal exposure to printed language. Tests of initial and final phoneme isolation were performed on all the children. Using a regression discontinuity design, it was calculated that the younger first graders outperformed the older Kindergarteners by an average of 32%. Within Kindergarten and first grade, there was a 9% difference in performance between the youngest and oldest children in the same year group. While both effects were significant, the effect of schooling was 3.5 greater than that of age. The conclusion was that training in reading was the main stimulant for the development of phonemic skills. The authors suggested that spontaneous cognitive maturation and increased informal experience with language and print were the causes behind the significant effect of age on phoneme awareness.

1.5.3 *Verbal memory*

Using the ‘cut off’ method Ferreira and Morrison (1994) examined age and schooling effects on the metalinguistic knowledge of two groups of twenty children. The children were asked to listen to a sentence and repeat the subject or the subject and verb. The subject was a pronoun, a name, a 2 word sequence or a 3 word sequence. It was found that children’s ability to isolate the pronoun improved with age, not schooling, whereas their ability to isolate the longest subjects improved with schooling, not age. It was suggested that the ability to retain longer sequences reflects the ability to manage working memory which improves as a result of school-based activities such as learning poems and songs. On the other hand, more sophisticated linguistic awareness (such as isolating pronouns) required a maturity that only developed with age. Similarly, Morrison et al., (1995) found that more schooled children outperformed less schooled children on a task which required them to remember the names of objects depicted in a set of pictures. Pairing names with visual stimuli is a skill that is practised often at school, so it is unsurprising that this skill showed a strong schooling effect.

1.5.4 *Vocabulary*

Frazier and Morrison (1998) conducted a study that compared Kindergarten pupils experiencing an extended school year (210 days) with pupils experiencing a traditional year (180 days). Children were tested for a variety of cognitive skills during the spring then again at the beginning of first grade to determine the effect of an additional 30 school days on the development of these skills. Results showed that receptive vocabulary showed similar patterns of improvement across the two groups and that there was no significant difference between their scores at the beginning of grade 1. On the other hand, the extended year pupils made more progress in reading and Mathematics than those experiencing the traditional year. The conclusion was that reading and Mathematics are strongly influenced by length of instruction while vocabulary is more likely to be affected by age-related factors.

A study by Christian and colleagues (2000) compared the progress of older Kindergartners with younger first graders over a period of six months. They found no significant difference in their vocabulary scores, but both groups improved over time. Consistent with the results of the Frazier and Morrison (1998) study, this suggests that age rather than school related factors are more important in the development of vocabulary.

To summarise, the research described above suggests that age has an effect on the development of phoneme awareness in the year preceding formal schooling. However, once reading instruction begins, length of time at school becomes the predominant influence on phoneme awareness (Bentin, et al., 1991; Bowey & Francis, 1991; Christian, et al., 2000; Morrison, et al., 1995). With regard to large segment awareness (syllable and sub-syllabic units), age is the principal influence, with most children having developed a good level of this skill by the time they start school (Christian, et al., 2000; Morrison, et al., 1995). Regarding verbal memory, there is evidence that the ability to repeat sequences of words within a sentence and to pair visual with verbal stimuli improves with schooling, not age (Ferreira & Morrison, 1994; Morrison, et al., 1995). Finally, two studies showed that increased exposure to schooling did not have a significant effect on vocabulary, implying that age-related factors were the predominant driving force behind the development of this skill.

1.6 Age and schooling effects on reading

England has an unusually low school entry age defined as ‘the year in which the child becomes 5’, meaning that children can be anywhere between just 4 and nearly 5 when they start school. There have been concerns within the education sector that early childhood teaching is not age appropriate. For example, the key stage one curriculum (ages 5-7) has been criticised for being too formal with too few opportunities provided for play and exploration (Blenkin, 1994; Sharp, Hutchison, & Whetton, 1994). Indeed, a recommendation to extend the current ‘early years foundation phase’ and delay formal schooling until age 6½ in the UK was made recently in the Cambridge primary review (2009). In particular, research within the education sector suggests that it is not developmentally appropriate to begin reading instruction before the age of 6-7 (Fisher, 2000; International Reading Association & National Association for the Education of Young Children, 1998; Juel, Biancarosa, Coker, & Deffes, 2003).

In order to address the question of when it is best to start teaching children how to read, it is necessary to examine the effect of age on reading development. It may be the case that formal instruction in reading is more effective beyond a particular age. If this is true, it might be better to wait until such an age before instruction begins. On the other hand, instruction of younger children may be equally effective as that of older children and age may play no role in the development of reading. If this were the case then it would not matter at what age you began teaching reading.

In order to put age effects in context, it is necessary to consider the effect of age in comparison to the effect of length of time spent at school on academic progress. Children who start school earlier in childhood will have 1-3 years additional schooling compared to children who start later in childhood. If age effects are considerably smaller than schooling effects, then it would be more beneficial for a child to have the extra years at school rather than the extra years in age. Taking into account school entrance ages across Europe, it is particularly relevant to look at such effects between the ages of 4 and 7.

Crone and Whitehurst, (1999) used a longitudinal two group ‘cut-off’ design to examine the development of literacy skills in 4-8 year olds. 337 children were recruited from the ‘Head start’ pre-school program and were followed until the end of second grade. Various measures of emergent literacy (phoneme awareness, letter recognition, print awareness) were taken at the end of pre-school and Kindergarten, and measures of reading (word reading and reading comprehension) were taken at the end of grades 1 and 2. It was found that the oldest children in kindergarten developed significantly better emergent literacy skills than their younger classmates. The effect of a year in Kindergarten on emergent literacy skills was 1.7 times stronger than the effect of age. Similar results were discovered with regard to the measures of reading taken in grades 1 and 2. In this instance, the effect of a year in first grade on reading was over 4 times stronger than the effect of age.

Morrison, Griffith and Alberts, (1997) discovered a similar pattern of results using a three group ‘cut-off’ design on 500 children from the US. Growth of reading and mathematics skills was measured by testing the children twice over a six month period. It was found that younger first graders made significantly faster progress in reading than older Kindergartners despite the fact that they were roughly the same age. This is not surprising given that children do not receive formal literacy tuition until Grade 1. Importantly, a small but significant age effect was observed during first grade with the older first graders achieving higher reading scores at the beginning and end of the year than their younger counterparts.

A large scale analysis of English, Maths and Science ‘SAT’ results collected from approximately 4,000 6-7 year olds in 1991 found that young summer-borns performed significantly less well than their older autumn born counterparts in all areas (Sharp, et al., 1994). The English test consisted of a reading, spelling and writing aspect and only a composite score was provided so it is not possible to tell which aspects of literacy showed the largest age effects. However, caution should be exercised in interpreting non-standardised tests such as the SATs as they produce only categorical data and scoring is somewhat subjective.

There are limitations to studies using the cut off method. For example, a confounder is age relative to peer group (age position effects). It is possible that greater expectations are placed on the oldest children in a class because they are more physically and emotionally mature, therefore inspiring them to achieve over and above their younger classmates and falsely enhancing absolute age effects (Sharp, George, Sargent, O'Donnell, & Heron, 2009). Furthermore, cut-off studies are restricted to children who are a maximum of 12 months difference in age and therefore may not be sensitive to developmental changes that occur over a longer period of time.

1.6.1 *Cross-cultural studies*

One way to avoid the limitations of cut-off studies is to look at cross-cultural data. Children are age 6 when they begin compulsory schooling in the US, Australia and most European countries and age 7 in Scandinavia and Singapore (Bertram & Pascal, 2002). Evidence from other countries suggests that British children are not at an advantage due to an earlier start. For example, the PIRLS study in 2006 (Progress in international reading literacy study) measured reading comprehension skills in children during their fourth year of formal schooling in 40 countries across the world. Children from Russia, Canada and Singapore were among the top four countries, while England was ranked 19th (Mullis, Martin, Kennedy, & Foy, 2007). Although a causal link cannot be made, it is interesting to note that the compulsory school starting age in each of these countries is 7.

Seymour et al., (2003) looked at the first year of reading development in English and 12 other languages. They found that English-speaking children who began school at age 4-5 needed on average 3 years in formal schooling to achieve 85% accuracy on tests of familiar word and non-word reading. Whereas, children from other European countries who began learning how to read at age 6-7 needed on average 1 year in formal schooling before achieving the same level. Unfortunately, age of starting school is confounded with orthography in this research. It was found that children from countries which used deep orthographies generally started school earlier and took longer to learn to read. In fact the rate of development in English was found to be more than twice as slow as in the shallow orthographies. It was suggested that the reason for this was that deep orthographies require a dual process approach to reading (alphabetic and orthographic) which requires greater processing resources than a single alphabetic approach. It was not possible in this instance to determine whether the slower development was due to age of starting, orthography, or both.

In an attempt to address this issue, I made a comparison between the reading levels of English and Danish children. Danish has a similar orthography to English in that they are both deep and complex languages. Danish children also begin school 2 years later than English children at age 6½. Re-analysis of the data showed that the Danish children performed significantly better than the English children on measures of familiar word reading: $t(93)= 6.51$, $p < 0.01$ and non-word reading $t(93)= 3.67$, $p < 0.01$ at the end of the first year of school. The implication was that the Danish children made faster progress than the English children because they were older. However, a causal link could not be made due to uncontrolled educational and cultural differences between the two samples.

1.7 Instructional effects on reading

Method of instruction is another factor in addition to age and length of time spent at school which has an important effect on early literacy development. Certain methods are more effective than others when it comes to teaching a child how to read (Snow & Juel, 2007). In particular, instruction which emphasises phonics is more effective than instruction which emphasises meaning at the level of words and sentences (National-Reading-Panel, 2000; Rayner, Foorman, Perfetti, Pesetsky, & Seidenberg, 2001). In this thesis, we are concerned with the effect of two different methods of instruction on the development of early literacy skills: The Steiner method and standard method as is practiced by mainstream schools in the UK.

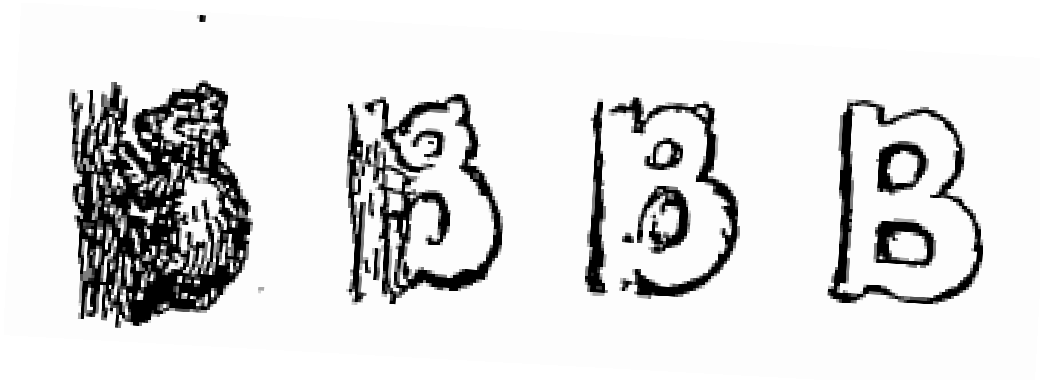
1.7.1 *The Steiner method of teaching reading*

Practice at Steiner schools varies depending on the way in which the class teacher interprets Rudolph Steiner's original teachings and the ability level of the class. However, there are certain key aspects of literacy instruction that are common to all Steiner classrooms (Bus & Kruizenga, 1986). Principally that reading should be taught in a flexible, non-pressurised manner in which children are allowed to progress at their own pace; 'at this age it is less important that the children begin to read right away than they become certain that, in time, they will be reading' (Schwartz, 2009, Class 2, Writing and Reading). Guidance for teachers on how to teach reading at Steiner schools is provided in Steiner's 'Practical advice to teachers' (1919/1976).

Crucially, the Steiner curriculum is based on what Rudolf Steiner indicated would be appropriate for children of each age in accordance with his view of child development. Up until the age of seven the child's energy is channelled mainly into physical growth and is therefore not available for academic study. The transition to the next stage is characterised by the loss of milk teeth which typically occurs at this age: 'if we teach him [reading] before the change of teeth …. then we are giving him things that lie right outside his nature and to which he has not the slightest relationship' (Steiner, 1924/1982 p.40). The process of teaching reading is experiential and continually related to the emotional and physical world. Pictures and images are used to stimulate the child's imagination which is considered the main gateway to learning for children of this age.

In Class 1 (6-7 years), the children are first taught how to form the capital of each letter with a crayon. Consonant letter forms are taught as emerging from pictures of animals and objects which begin with the target letter (see Figure 1.1). Such an approach is designed to echo the natural evolution of letter symbols as human expression through pictures (Rawson & Richter, 2000). After each letter is drawn, its corresponding name (and sometimes sound) is taught. Children draw pictures of each letter and surround them with drawings of words which begin with the same sound or name. Vowels are introduced with reference to emotional expressions e.g., the 'Oh' sound made when surprised is related to the name of the letter 'O' while the form of the letter is related to the shape one makes with their arms when embracing someone.

Figure 1.1. Illustration of the letter B emerging from a picture of a bear climbing a tree



Note. Reproduced from Bus & Kruizenga, 1986.

In Class 2 (7-8 years), books are introduced into the classroom and children are taught to read and write whole words through a mixture of whole sentence and phonic work. Due to the fact that this is the first year in which children were expected to read/spell whole words independently, it was considered the first year of formal reading instruction in the current thesis. A defining feature of the Steiner approach at this time is the 'recitation method'; children copy complete sentences from the board (which they cannot yet read) and learn to recite them off by heart. Through regular recitation, they learn to recognise the various words, and, in time, identify them in new contexts (Rawson & Richter, 2000; Schwartz, 2009). In order to stimulate this process, the teacher points to words or phrases in a random order, or has the class read the text from the back to front. To avoid embarrassing any child who feels that he/she can't keep up, these exercises are always carried out as a whole class activity.

Whole sentence work (using the recitation method) is supplemented by phonic work. During Class 2, children begin learning lower case letters and the focus is turned to letter sounds in addition to names (e.g., the difference between long and short vowel sounds). A defining feature of this work is emphasis on the initial phoneme (onset), with only minimal referral to phonemes in other positions. For example, pantomime-type games are played during which children have to guess which words begin with a certain letter; these words are then written on the board by the teacher (Bus & Kruizenga, 1986). Such an approach is similar to the analytic phonics method formerly practised in mainstream schools in the UK (Rose, 2006). In Class 3 (8-9 years), literacy instruction is extended to include more whole book work. Printed booklets are used, but the method is roughly the same as in Class 2; the teacher first reads the text, after which the children read along together. At this time, parents are invited in to run weekly reading groups. No particular reading scheme is followed; rather, texts are selected by the class teacher on the basis of content and quality of illustrations.

Bus and Kruizenga, (1986) tested children in Classes 1-3 at a Steiner school in the Netherlands. At the end of Class 1, only 5% of children achieved 80% or more correct on a word reading test. This was in contrast to previous work by the first author which found that 85% of children of the same age in a standard primary school achieved this level of accuracy by the end of their first year (Bus, 1984). Additionally, 20% of the Steiner children still could not successfully decode simple CV, VC and CVC words at the end of class 2. Analysis of spelling errors revealed that the majority of errors were made on the middle vowel sound, followed by the end consonant, with the least number of errors made on the initial consonant. This is consistent with the analytic approach to phonics advocated in Steiner schools where initial sounds are emphasised first.

The authors concluded that, as a result of the Steiner method of teaching reading, the children in their study struggled to implement basic decoding strategies in comparison to their peers at standard Dutch schools. This was particularly true for the ‘less able’ children (lowest 20% on word reading). The authors claimed that these difficulties were caused by a lack of synthesis skills and poor knowledge of vowel sounds. Consequently, they recommended that Steiner teachers needed to spend more time teaching letter sounds, and that more focus needed to be given to segmenting and blending whole words at the level of the phoneme.

1.7.2 *The standard (UK) method of teaching reading*

The method of initial reading instruction currently followed by the majority of standard schools in the UK is the ‘Letters and Sounds’ program ("Letters and Sounds: Principles and practice of high quality phonics," 2007). The program is followed during the first two years of formal schooling; Reception and Year 1 (4-6 year olds). ‘Letters and Sounds’ is based on a synthetic phonics approach whereby children are taught to analyse and synthesise words based on their constituent phonemes. Words are ‘built-up’ using letter blocks (phonemic analysis), then the letters are sounded and blended (phonemic synthesis) in a left to right sequence in order to pronounce the whole word. All 40+ grapheme-phoneme correspondences in the English language (including digraphs e.g., ‘ie’ and ‘ph’) are gradually introduced in an organised manner across the two years until all regular and semi-regular words can be decoded using phonetic strategies. The program prescribes 20 minutes a day of phonic work. Sounds are taught using a multi-sensory approach involving songs, movement, and visual/ auditory cues e.g., ‘s’ is denoted by a picture of a snake which is accompanied by an undulating action with the hand to go with the sound ‘ssssssss’. In addition, Reception-age children are normally taught to recognise a set of a hundred key irregular words by sight (‘tricky words’).

A further recommendation to schools is to have regular guided reading sessions in keeping with current guidelines to embed phonics within a broader language curriculum ("Curriculum Guidance for the Early Years Foundation Stage," 2008). Guided reading sessions usually last half and hour and occur twice a week. During these sessions, children are aided in small groups to read books from a reading scheme ("Oxford Reading Tree," 2009).

A study by Johnson and Watson, (2004) provides evidence that the synthetic phonics approach is more successful than analytic phonics at achieving fast initial progress in literacy. The study compared the literacy achievement of 3 matched groups of children during the first term of formal schooling; 2 were exposed to whole-class analytic phonics (as was standard practice at the time) and one was exposed to whole-class synthetic phonics. Results showed that immediately after the intervention, the synthetic group had made greater gains in reading, spelling, letter knowledge, and phoneme segmentation skills than the analytic groups. Differences in favour of the synthetic group were sustained 15 months after the intervention, with particular gains in spelling. However, these results should be interpreted with caution due to differences in the amount of training the teachers received and the fact that they were not blind to the outcome of the study.

In addition to the Johnson and Watson (2004) study, there is a large body of research which points to the efficacy of the synthetic phonics approach to the development of early reading (Byrne & Fielding-Barnsley, 1991) with particular advantages for spelling (Bowyer-Crane, et al., 2008; Bradley & Bryant, 1983). However, those studies which also measured reading comprehension skills found no significant advantages for the synthetic phonics groups compared to controls (Bowyer-Crane, et al., 2008; Torgesen, et al., 1999).

1.8 Overview of thesis

This thesis aims to address seven outstanding areas of inquiry as identified by the above review. First, previous research on the role of age and schooling in the development of reading-related skills is largely restricted to studies employing the cut-off design where children are a maximum of 12 months difference in age. Chapter 2 presents a cross-sectional study of children differing by either 3 years of age or 3 years of schooling. This allowed investigation of age and schooling effects on phonological awareness, vocabulary and verbal memory skills across the full extent of the ‘5-7 shift’. Second, the question of whether phoneme awareness can develop in the absence of reading instruction is also addressed in chapter 2 by measuring this skill in two groups of children with minimal or no measurable reading ability.

Third, educational debate has created the need for more empirical research on how school starting age affects the development of literacy. In particular, there is a need for studies of matched groups of children who speak the same language but who differ by several years in age to reflect differences in school starting ages across the world. In chapter 3, this gap is addressed by comparing the early reading progress of a group of Steiner-educated 7-year-olds and a group of standard-educated 4-year-olds over a period of two years. The effect of age as well as the Steiner and standard methods of teaching reading is investigated.

Fourth, there is very little research on how age and instructional method might impact upon the skills which underlie early literacy development. Chapter 4 addresses this issue by examining the predictors of reading and spelling in older, Steiner-educated children compared to younger, standard-educated children.

Fifth, there is a wealth of evidence that links phoneme awareness with letter knowledge and reading. However, the direction of this relationship and a possible causal link between variables is still unclear. Chapter 5 looks at whether letter-sound knowledge precedes phonological awareness or vice versa, and which factors might affect the strength or direction of this link. This chapter uses data from the longitudinal study presented in chapter 3 to see whether the nature of this relationship is altered by age or instructional method.

Sixth, the measurement of phoneme awareness in beginning readers has typically been restricted to static tasks. Such tasks may underestimate PA in young children because they are too difficult, as shown by floor effects in the data. Chapter 6 presents a longitudinal study which employs a dynamic measure of phoneme awareness to measure this skill during the first two years of standard schooling.

Finally, by using the cut-off design, the study in chapter 6 further investigates age and schooling effects on phoneme awareness and early literacy skills by comparing matched groups of children exposed to the same instructional method who differ by up to one year in age or one year of schooling.

2 Reading-related skills in earlier and later schooled children

Abstract

This study investigates the effects of age-related factors and formal instruction on the development of reading-related skills in children aged four and seven years. Age effects were determined by comparing two groups of children at the onset of formal schooling; one aged seven (later-schooled) and one aged four (earlier-schooled). Schooling effects were measured by comparing the later-schooled group with earlier-schooled age-matched controls. There were significant effects of age and schooling on phonological awareness (a composite of syllable and phoneme awareness) and visual-verbal learning, and an effect of age, but not schooling, on vocabulary and short-term verbal memory. Also, it was shown that vocabulary was more closely associated with phonological awareness in the earlier schooled group. We conclude that age-related factors and reading instruction contribute to the development of phonological awareness and that vocabulary and verbal memory improve with age, not schooling.

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2.1 Introduction

Previous research has shown evidence of a significant improvement in cognitive skills between the ages of 5 and 7, otherwise known as the '5-7 shift' (Morrison, et al., 1996). Of these, many have been related to early reading, such as vocabulary, verbal memory and in particular phonological awareness, all of which show an important developmental change at this time (Muter, Hulme, & Snowling, 1997; Wagner, et al., 1997). However, such changes have previously only been shown in children who began receiving formal reading instruction between the ages of 4 and 6. Therefore, it is unknown to what extent the improvements may have been stimulated by the process of reading itself or by age-related processes such as spontaneous maturation and informal experience of language (referred to in the current paper as age effects). We address this issue in the present study by comparing three groups of children: two groups tested shortly after the onset of formal reading instruction, one younger and one older, and a matched older group of experienced readers. The results will help to elucidate the relative contributions of age and formal instruction in reading on the development of reading-related skills during the first years of school.

It is reasonable to assume that exposure to formal reading instruction would lead to a corresponding improvement in reading-related skills. In line with this hypothesis, there is evidence of bidirectional relationships between reading-related skills and reading. For example, phonological awareness is thought to have a reciprocal relationship with reading with gains in one leading to gains in the other, and vice versa (Perfetti, et al., 1987; Wagner, et al., 1994). There is also evidence of 'Matthew effects' in reading whereby cognitive development is enhanced through a process of 'bootstrapping' (Stanovich, 1986). For instance, reading will increase exposure to new words, thus improving vocabulary while vocabulary helps children to decode new words, thus improving reading. In line with this hypothesis, Stanovich, Nathan & Valarossi (1986) found that poor readers in fifth grade had similar levels of vocabulary and phonological skills to reading matched controls in third grade.

Age-related processes independent of formal reading instruction also play a role in the development of reading-related skills. For example, spoken word vocabulary develops in pre-literate children, stimulated by exposure to oral language (Metsala, 1999). Additionally, vocabulary can be further enhanced by being read to in school and at home (Bus, et al., 1995; Lonigan, Anthony, Bloomfield, Dyer, & Samwel, 1999). Furthermore, studies have consistently shown evidence of large segment (syllable and rime) awareness in pre-school children who have not yet been exposed to formal reading instruction (Carroll, et al., 2003; Lonigan, et al., 2000). Researchers have argued that such awareness can be stimulated at school or at home by activities such as singing songs, rhyming games (Goswami & Bryant, 1990), and being read to (Lonigan, et al., 1999). Therefore, it is reasonable to assume that given these informal experiences of language, skills like vocabulary and syllable awareness would continue to develop in the absence of formal reading instruction.

2.1.1 *Measuring the effects of age vs. formal instruction*

Previous studies have typically confounded age with length of reading instruction, making it difficult to disentangle the effects of each. One way of separating the two is to use the 'cut-off' method (Morrison, et al., 1995). Such studies use the natural school cut-off date to examine the youngest and oldest pupils in the same year group. This way, children may be matched on exposure to school-based reading instruction but differ by up to twelve months in age. Conversely, the effect of formal reading instruction can be measured by comparing the oldest children in a year group with the youngest children in the year above. This way, participants may be approximately matched on age but differ by one year of schooling.

A limitation of cut-off studies is that, due to being constrained by the school cut-off date, they can only compare children who are a maximum of twelve months difference in age. Therefore, any differences observed will be limited to a small window of development and as a consequence, the effect of age may be underestimated. In addition, the groups in cut-off studies, although closely matched on background variables, typically are not matched for reading ability (between the oldest and youngest in the same year group) (Bowey & Francis, 1991; Morrison, et al., 1997). Therefore, the superior reading-related skills of the older children may be due to their superior reading ability. The current study seeks to address these limitations by comparing reading-related skills in non-reading children of the ages of four and seven and an age-matched control group of seven year-old readers. The comparison can be viewed as an extension of the cut-off method, comparing children of three years difference in age with similar levels of exposure to formal instruction and an age matched control group with 3 years additional instruction.

2.1.2 *Age and schooling effects on vocabulary and memory*

In a study using the cut-off method, exposure to formal schooling in grade one was found to be the major determinant of the ability to retain the names of pictures in working memory, while there was no significant effect of age (Morrison, et al., 1995).

Similarly, a study by Ferreira and Morrison (1994) found that children's ability to isolate and repeat the longest subjects in a sentence improved with schooling, not age. On the other hand, vocabulary has been found to be relatively unaffected by early schooling experiences. Frazier and Morrison (1998) found no difference in the vocabulary of Kindergartners who had experienced an extended school year compared to those who had experienced a shorter year. In addition, a study by Christian, Morrison, Frazier and Massetti (2000), using the cut-off method, found no significant effect of schooling on a measure of receptive vocabulary during Kindergarten and First Grade. Age effects were not measured.

2.1.3 *Phonological awareness*

Early studies on the development of phonological awareness argued that awareness of large units (syllables and onset/rimes) preceded awareness of small units (phonemes), and that both were important independent longitudinal predictors of literacy development (Bryant, Maclean, Bradley, & Crossland, 1990; Bryant, Nunes, & Bindman, 1998). However, more recent work has cast both of these hypotheses into doubt. For example, rime awareness does not necessarily precede phoneme awareness (PA), particularly on explicit phonological awareness tasks (Duncan, et al., 1997; Geudens & Sandra, 2003). Furthermore, phoneme awareness seems to be more important than rime awareness in the prediction of literacy development (Hulme, et al., 2002; MacMillan, 2002; Savage, et al., 2005). These results suggest that a focus on phoneme awareness may be particularly crucial for this study.

However, one potential problem with focusing on phoneme awareness tasks rather than rime and other types of phonological awareness is that alphabetic literacy is in itself a major cause of growth in phoneme awareness. For example, studies have shown that PA develops rapidly during the first year of learning to read (Muter, Hulme, Snowling, et al., 1997; Wimmer, et al., 1991) and that pre-readers struggle with PA tasks (Hulme, et al., 2002). The strongest interpretation of the evidence is that phoneme awareness does not, in fact, develop in the absence of alphabetic literacy (e.g., Castles & Coltheart, 2004).

Recent research, however, has led to evidence that non-readers can solve certain explicit phoneme awareness tasks. For example, Geudens and Sandra, (2003) showed above chance levels of the ability to segment two-phoneme syllables in 6 year old Dutch speaking children who had not yet begun formal reading instruction. In addition, Hulme, Caravolas, Malkova and Brigstocke, (2005) showed significant phoneme isolation ability in Czech (age 6) and English (age 5) children at school entry. However, in both studies, the majority of children were in possession of some letter knowledge at time of testing. Letter knowledge is a precursor of alphabetic literacy that has been strongly associated with phoneme awareness during the pre-school years (Burgess & Lonigan, 1998; Carroll, 2004). Hence, it may account for the PA skills demonstrated in the above studies.

Caravolas, (2006) argued that English speaking children may be relatively late to develop phoneme awareness because of particular characteristics of the English language, and that this, coupled with the tendency for English speaking children to begin reading instruction earlier than in other countries (Bertram & Pascal, 2002), may account for why phoneme awareness does not seem to develop in the absence of literacy in English. One way to assess this claim is to examine whether English speaking children who begin reading instruction later show any phoneme awareness. This is addressed in the current study.

2.1.4 *Age and schooling effects on phoneme awareness*

Previous research suggests that phoneme segmentation skills may be stimulated by age-related processes during the year preceding formal reading instruction (usually called Kindergarten). For example, Bentin, Hammer and Cahan (1991) found that older Kindergarteners (age 6) in Israel significantly out-performed younger Kindergarteners (age 5) on tests of phoneme segmentation. In the US, Morrison et al. (1995) found a significant age effect on a similar test of phoneme awareness during the Kindergarten year. However, this age effect did not persist during first and second grade (during which there were large gains in PA). At the time of testing, formal reading instruction in the US typically did not start until first grade. Therefore, it would appear that once formal teaching of reading begins, its effect on PA is so powerful that it supersedes the age effect. However, age does seem to have an effect during the ‘pre-reading’ phase in pre-school. Mann (1986) found that Japanese first graders (age 6-7) instructed in a non-alphabetic script were not able to manipulate phonemes, while American first graders could. However, by fourth grade (age 9-10), most Japanese children could delete phonemes indicating a significant effect of age on the development of this skill.

2.1.5 *Age effects on the relationship between phonological awareness and vocabulary*

There is evidence that vocabulary levels are closely associated with phonological skills in the preschool and early school years but that this association decreases during the later school years (e.g., compare Snowling, Gallagher, & Frith, 2003; and Snowling, Muter, & Carroll, 2007). In some studies of pre-school children (up to the age of 5), vocabulary has been found to be an important concurrent and longitudinal predictor of phonological awareness (Carroll, et al., 2003; Lonigan, et al., 2000; McDowell, Lonigan, & Goldstein, 2007). However, in older children this is less frequently the case. For example, Wagner et al., (1997) found that vocabulary was a unique predictor of phonological awareness from Kindergarten to second grade and from first grade to third grade but not from second grade to fourth grade.

There are several possible explanations for these changes. Scarborough and Dobrich (1990) argue that vocabulary tests measure different skills at different ages. Early in development, children's acquisition of vocabulary may be limited by their ability to process sound sequences, while later in development it is more dependent on other skills, such as understanding and interpreting verbal context. Another possible explanation is offered by the lexical restructuring hypothesis (Metsala & Walley, 1998; Walley, 1993). Walley argues that phonological processing abilities are dependent on vocabulary size. As children acquire new vocabulary, increasing pressure is placed on their lexicon and words must be represented in greater phonological detail, thus increasing phonological awareness for those words. Walley does not give definite ages for the start and end of this vocabulary 'growth spurt', but it is thought to take place during the pre-school and early school years (Metsala, 1999).

Both research groups cite the introduction of literacy instruction as playing a key role in the changing relationship between vocabulary and phonological awareness. One of the reasons for this is that literacy instruction allows children to begin to use explicit metalinguistic awareness to solve phonological tasks (Gombert, 1992). However, no research has yet examined the relationship between these skills in older children who have not yet begun formal literacy instruction. These children will have a large vocabulary, but relatively undeveloped metalinguistic skills in comparison to other children of their age in standard education. The current research will examine whether the relationship between phonological awareness and vocabulary in this group is similar to that of younger children at the same reading level, or that of age matched children of the same vocabulary level.

2.1.6 *The current study*

In order to separate the effects of formal schooling and age, it was necessary to access a group of children who began school at a different age from usual. In the UK, standard educated children enter formal schooling during the academic year in which they turn five. One group of children who start at a substantially later age are those educated at Steiner schools. According to the Steiner philosophy, formal learning, including the teaching of reading, should not begin until age seven. Prior to this age, children attend the Steiner Kindergarten which caters for all those between the ages of three and seven. Steiner Kindergartens are essentially play-based and there is no specific teaching of literacy or mathematics during this time (Steiner, 1924/1982). Therefore, the effect of age can be determined by comparing a group of older, later-schooled (Steiner) children with a group of younger, earlier-schooled children (reading controls), both at the onset of formal education and in possession of no or minimal reading skills. Schooling effects can be calculated through comparison of the later-schooled children with a group of earlier-schooled age matched controls.

Three main questions were addressed:

1. What is the effect of formal schooling compared to age-related factors on the development of vocabulary and verbal memory skills?
2. What is the role of formal instruction in reading compared to age-related factors in the development of phoneme awareness?
3. Does the relationship between vocabulary and phonological awareness change with age or exposure to formal reading instruction?

2.2 Method

2.2.1 *Participants*

Participants were 93 children out of 167 who participated in the initial screening procedure, recruited from four schools in the United Kingdom. Thirty later-schooled children (average age 7,10 years; range 7,3 to 8,3) were compared to 33 earlier-schooled reading controls (average age 4,9 years, range 4,3 to 5,2), and 30 earlier-schooled age controls (average age 7,10 years; range 7,6 to 8,3). The later-schooled group consisted of 15 boys and 15 girls, the reading control group of 14 boys and 19 girls, and the age control group of 16 boys and 14 girls.

2.2.2 *The schools*

The later-schooled children were recruited from two independent Rudolf Steiner schools in the London area. The first school (n = 21) was located in a semi-rural Suburban area. According to the latest ACORN statistics ("ACORN statistics," 2009) (which combine demographic and lifestyle variables to describe the characteristics of different postcodes in the UK), the school was in a 1,C,9 area: Category; wealthy achievers, Group; flourishing families, Type; larger families, prosperous suburbs. Out of a total of 45 children in the two Class Two classes, 41 participated in the initial screening procedure. Two children did not participate because they did not speak English at home with either parent, one child had severe learning difficulties, and one had parental consent withdrawn.

The second Steiner school (*n* =9) was located in an urban area of inner-city London. ACORN classified it as being in a 5, Q, 55 area: Category; hard-pressed, Group; inner-city adversity, Type; multi-ethnic purpose built estates. However, due to the fee-paying nature of the school, most children travelled in from the more affluent surrounding areas. Out of a total of 16 children, parental consent was acquired from 14 parents, all of whom participated in the initial screening procedure.

The earlier-schooled, reading matched controls (*n* =33) were recruited from one state-run Infant school in a semi-rural area of Warwickshire. It was classified by ACORN as being in a 1,A,1 area: Category; wealthy achievers, Group; wealthy executives, Type; affluent mature professionals, large families. Sixty children participated in the initial screening procedure.

The earlier-schooled, age matched controls (*n* = 30) were recruited from one state-run Junior school in the Warwickshire area. It was located in a semi-rural area, classified by ACORN as a 3,H,28 postcode: Category; comfortably-off, Group; secure families, Type; working families with mortgages. Out of 86 children in the three classes, parental consent and home literacy environment questionnaires were acquired from 60 parents. Seven children were excluded due to not falling within the required age-range. Therefore, 53 children took part in the initial screening procedure.

2.2.3 *Educational practices*

The later-schooled children were tested during the first semester of Class Two (7-8 years). Children were exposed to letters in Class One (6-7 years) and learnt some sounds and names. However, there was no formal relation of these sounds to decoding words. Parents were discouraged from teaching their children how to read at home and engaging in 'reading-readiness' activities. Previous to this, the children had attended the Steiner Kindergarten for three to four years (3-6 years). At this time, they were deliberately shielded from the influence of formal teaching and although the children were told stories and sang songs, there was no relation of language to the printed word.

The reading controls were tested during the first semester of the Reception year (4-5 years), which is the first year of formal reading instruction in the UK. Some children had previously attended preschool (2-4 years) for one to two years and had been exposed to letters in an informal context. In addition, a certain amount of phonic work had already taken place during the first part of the Reception year which mainly involved learning letter sounds. The age controls were tested during the second semester of Year 3 (7-8 years). They had all attended school since the Reception year and had experienced an average of 3½ years formal reading instruction at time of testing.

2.2.4 *The screening and matching procedure*

A sample of 55 later-schooled 7-8 year olds (representing 89% of children in the year group and excluding children with severe learning difficulties) was initially tested for word reading. Thirty-one of them reported attending a Steiner school since Kindergarten and claimed not to have been taught how to read at home by their parents. Eleven children said that they had previously attended a standard school where reading had been taught and 18 children (five of whom had also attended a standard school) reported to have been taught reading at home by their parents. These latter two groups (n=24) were excluded because they could all read more than 5 words on the British Ability Scales (BAS) word reading test (mean = 34.96, SD=24.79, range 7 -71). The remaining 31 children who had been pure ‘Steiner-taught’ were found to have no or minimal reading skills (≤ 5 on the BAS). Complete data for one child was not obtained due to him being absent for virtually the entire testing period, resulting in a final sample of 30. Home literacy environment questionnaires were sent home twice and were returned by 21/30 parents. Data on maternal education level was obtained from an additional three children during a follow-up visit.

Sixty 4-5 year olds (representing 100% of the children in the year group) were screened for word reading ability (mean =1.18, *SD* = 5.70, range 0-43), and vocabulary (mean standard score= 111.05, *SD* =10.25, range 80-131). One child was excluded due to scoring more than 5 on the BAS. Each child in the later-schooled group was matched to one child from this group on the basis of standardised vocabulary score (within five points). This was to ensure that there was a similar level and distribution of verbal ability (as expected for their age) in each group. Finally, an additional 3 children were selected such that the groups were also matched for average score on the home literacy environment questionnaire. Therefore, 33 earlier-schooled reading controls were selected for the final sample. Home literacy environment questionnaires were sent home twice to this group and were returned by 24 parents. An additional two questionnaires were obtained during a follow-up visit.

A sample of 53 earlier-schooled 7-8 year-olds (representing 62% of children in the year group) was initially screened for word reading ability (mean = 58.81, SD =12.49, range 6-74). Each child for the final sample was selected on the basis of three criteria: First, one, two or three participants were matched to one of the later-schooled children according to age (within three months). Of these children, one or two were selected on the basis of having the highest maternal education score, and finally (if more than one child remained), the one with a standardised reading score closest to the national average was selected. This produced a final sample of 30 earlier-schooled age controls.

2.2.5 *Design and Procedure*

Children were tested individually by the first author in a quiet corner of the school. Tasks were administered over a period of 3-4 weeks for each group. The later-schooled and age control children were tested during two sessions lasting 20-30 minutes and the reading controls during three sessions lasting about 15 minutes each. Sessions for the younger children were shorter to encourage them to remain focused. Children in the first two groups completed a total of seven tasks each, while children in the age control group completed six tasks each (as all children in this group were skilled readers, it was assumed that they would perform at ceiling for the letter knowledge task). Tasks were presented in fixed order with the language and phonological tests interspersed to maintain interest. The deleting and blending sounds tasks and non-word repetition task were presented orally by the experimenter, which differs from the usual procedure with a standardised recording. This is because teachers at the Steiner schools were not comfortable with the children receiving pre-recorded tests.

2.2.6 *Materials*

Reading tasks

Word reading. The children were asked to attempt to read the first 20 words from the British Ability Scales 2 (BAS). Single words were printed in large font on a sheet of paper. If the child was not able to read any of the first ten words then the test was stopped. Guessing was encouraged. If a child did not know a word, they were asked to try and 'sound it out' and then blend these sounds together.

Letter-sound knowledge. Each of the 26 lower case letters were presented individually on cards in random order. Children were asked to pronounce the sound of the letter. If they replied with the letter name, they were asked if they knew what the letter sound was. Letter-sound knowledge was used in the analyses. This test was untimed. Sample-specific reliabilities for this task were high: Later-schooled group, Cronbach's $\alpha = .87$; reading controls, $\alpha = .92$.

Phonological tasks

Deleting sounds. Children's ability to segment and manipulate sounds at the level of the syllable and phoneme was measured using the elision test from the Comprehensive Tests of Phonological Processing (Wagner, Torgesen, & Rashotte, 1999). The test was divided into two sections, both preceded by 3 practice items. The first section consisted of three items where children were asked to delete the first or final syllable of a word, the first two of which were compound words. The children were asked, for instance, 'Say popcorn. Now say popcorn without saying corn'. Corrective feedback was given for each item in this section. In each case, at least one of the practice items had to be answered correctly to ensure understanding of the task before proceeding. If none of the practice items was answered correctly then the test was stopped at that point. After three more practice questions, the second section began with 5 items that required deletion of the initial or final phoneme of a word (e.g., 'Say tan without the /t/') followed by 12 questions that require deletion of a word's medial phoneme. Corrective feedback was given for the first two items only. The test was stopped after 3 consecutive incorrect responses. Both stimuli and answers were real words. The experimenter presented the items orally, which differs from the usual procedure with a standardised recording. This is because teachers at the Steiner schools were not comfortable with the children receiving pre-recorded tests. Sample-specific reliabilities for this task were good: Later-schooled group, Cronbach's $\alpha = .82$; reading controls, $\alpha = .87$; age controls, $\alpha = .81$.

Blending sounds. Children's ability to blend syllables and phonemes was measured using the blending words test from the Comprehensive Tests of Phonological Processing (Wagner et al., 1999). There were five practice items followed by 20 test items. The first three items were bi-syllabic words. Each syllable was pronounced by the experimenter with a short pause in between and children were asked to blend them together to make a word. For instance, 'What word do these sounds make? ham-er'. The following eight items were monosyllabic words. Here, the experimenter pronounced individual sounds e.g. 'm–i-s'. The first five consisted of 2 phonemes to be blended together; the next three had 3 phonemes to be blended. The remaining nine items had 4+ phonemes to be blended and ranged from 1- 4 syllables long. Corrective feedback was given for the practice items and the first three test items. Items were presented orally by the experimenter. Sample-specific reliabilities for this task were medium - high: Later-schooled group, Cronbach's $\alpha = .81$; reading controls, $\alpha = .91$; age controls, $\alpha = .67$.

Language tasks

Receptive Vocabulary. Vocabulary was measured using the British Picture Vocabulary Scale, 2nd edition (Dunn, Dunn, Whetton, & Burley, 1997). Children were asked to point to one of four pictures to identify a word spoken by the experimenter. The test continued until the child made eight or more errors in a block of ten. This test was standardised in the UK for children between the ages of 3 and 15. Sample-specific reliabilities for this task were high: Later-schooled group, Cronbach's $\alpha = .93$; reading controls, $\alpha = .89$; age controls, $\alpha = .81$.

Recalling sentences. Knowledge of sentence structure and verbal short-term memory were evaluated using the Recalling Sentences test from the school age version of the Clinical Evaluation of Language Fundamentals (CELF -3/UK) (Semel, Wiig, & Secord, 1995). Children were introduced to two puppets. The child took on the role of one of the puppets. The examiner's puppet said 'Now I am going to say some things to you. I want you to listen carefully and repeat exactly what I say' (e.g.,' My sister is in year eight') If the child repeated the sentence verbatim then they received a score of 3, if they made one error, a score of 2, and 2-3 errors, a score of 1. No response or four or more errors received a score of 0. There were two practice trials with corrective feedback followed by 26 test items. The test was discontinued after three consecutive scores of 0. Sample-specific reliabilities for this task were high: Later-schooled group, Cronbach's $\alpha = .90$; reading controls, $\alpha = .87$; age controls, $\alpha = .85$.

Non-word repetition

The Non-word repetition task from the Comprehensive Tests of Phonological Processing (Wagner et al., 1999) was used to measure children's short-term verbal memory. Again, the task was presented with puppets. This was a non conventional version of the test, designed to encourage children's engagement. Children were told that Cookie monster was going to teach his language to Giraffe by saying one word at a time and then asking Giraffe to repeat it back to him exactly how he said it. Children were asked to listen carefully to what Cookie Monster said so that they could repeat it accurately. All stimuli were non-words pronounced orally by the experimenter. There were three practice items. If the child got a practice word wrong, it was repeated and then corrective feedback given. The first three test items were single syllable non words and the following 15 consisted of gradually longer non words up to seven syllables long (e.g., meb and dookershatupietazawm). Feedback was given for the first three test items only. The test was discontinued after 3 consecutive incorrect responses. Sample-specific reliabilities for this task were less good: Later-schooled group, Cronbach's $\alpha = .65$; reading controls, $\alpha = .43$; age controls, $\alpha = .66$.

Visual-verbal learning

The ability to remember associations between visual and verbal stimuli was measured using a visual verbal learning task. The current paradigm was adapted from the memory confusions task developed by Treiman and Breaux (1982). The test consisted of three sections. To begin, the children were introduced to three finger puppets (e.g. duck, starfish and elephant). They were told 'I'm going to see how well you remember their names. Listen carefully because you won't have heard the names before'. Children were asked to repeat each name after the experimenter to ensure that it had been heard correctly e.g. ‘The duck is called Pim. Can you say that?’ Corrective feedback was given if the child pronounced the name incorrectly. Next, the experimenter mixed the order of the puppets and the child was asked to point to the puppet named by the experimenter e.g., ‘Which one is Tane?’. Each set of three responses formed a triad, with a maximum of six triads per section. After each triad, the puppets were mixed up again and the names pronounced in a different order. The test was discontinued after all three puppets were correctly recognised for two consecutive triads and children were given full marks for the remaining four triads. In the second and third section, the procedure was repeated with different finger puppets and names such that children were introduced to nine puppets by the end of the task. There was a maximum of 18 triads and 54 individual responses. The final score was calculated as the total number of correct individual responses. Sample-specific reliabilities for this task were high: Later-schooled group, Cronbach’s $\alpha = .91$; reading controls, $\alpha = .90$; age controls, $\alpha = .81$.

Home Literacy Environment

A questionnaire adapted from the Family reading survey used by Samuelsson et al., (2005) was handed out to parents (see Appendix 1). Twenty-one parents from the later-schooled group (70% of the sample), 26 parents from the reading control group (78% of the sample) and 30 parents from the age control group (100% of the sample) completed the questionnaire. It consisted of 16 questions which focused on the child’s exposure to literacy-related activities in the home and 2 questions on parental education level. Questions covered factors such as frequency of shared book reading, number of children’s books in the home, frequency of parents’ private reading, and age at which parents began reading to their child, all of which have been shown to account for substantial variance in the emergent literacy skills of pre-schoolers (Burgess, et al., 2002; Bus, et al., 1995; Payne, Whitehurst, & Angell, 1994; Samuelsson, et al., 2005).

Questions pertaining to shared-book reading activities were considered an inappropriate comparison for the parents of independent readers, and were therefore omitted from the questionnaire given out to the age control group. Hence their questionnaire consisted of only 9 items. A composite score was calculated for the 6 questions about family literacy (all groups), and 9 questions about shared-book reading activities (later-schooled and reading control group only). There was some missing data due to some parents leaving certain questions blank (results and reduced ns are reported in Table 2.1). There was no significant difference in letter-knowledge between the children whose parents did and did not return the questionnaire; $t(28) = 1.7$, $p > .05$, later-schooled, $t(31) = .37$, $p > .05$, reading controls.

2.3 Results

2.3.1 *Background characteristics*

Table 2.1 shows background characteristics for the three groups. ANOVAs revealed that exposure to reading-related activities in the home was broadly similar across groups. There was no significant main effect of group on shared book reading, $F(1,43) = 0.21$, $p = .65$, $r^2 < .01$ (later-schooled and reading control groups only), family literacy, $F(2,70) = 1.25$, $p = .29$, $r^2 = .05$ or the age the parents began reading to their child, $F(2, 71) = 1.18$, $p = .31$, $r^2 = .04$. There was, however, a main effect of group on paternal education level, $F(2, 71) = 5.15$, $p < .01$, $r^2 = .08$. Fathers in the later-schooled group were better educated than those in the reading control group, $t(71) = 2.44$, $p < .05$,

$r = .28$, but there was no significant difference between the two older groups, $t(71) = -0.37$, $p = .72$, $r < .01$.

There was also a main effect of group on maternal education level, $F(2,76) = 10.08$, $p < .01$, $r^2 = .37$. Mothers in the later-schooled group were better educated than those in the reading control group, $t(76) = 4.48$, $p < .01$, $r = .50$, and age control group, $t(71) = 2.44$, $p < .05$, $r = .28$. Maternal education is highly reflective of a child's socio-economic status, a variable that has been shown by numerous studies to influence early language and phonological skills (Bowey, 1995; Lonigan, Burgess, Anthony, & Barker, 1998). Maternal education is therefore co-varied in the main analyses below.

Table 2.1

Background characteristics of the three groups

	Earlier-schooled age matched controls		Later-schooled group		Earlier-schooled reading matched controls	
Variable	*M (SD)*	Range	*M (SD)*	Range	*M (SD)*	Range
Age [a]	93.80 (3.12)	90 - 99	94.13 (3.65)	87 – 99	57.39 (3.87)	51– 62
Standardised Vocabulary [b]	107.87 (8.11)	90 -126	104.77 (10.96)	85 –126	105.61 (10.27)	89–131
Word reading	59.67 (8.33)	40 - 74	1.03 (1.43)	0 – 5	0.52 (0.80)	0–3
Maternal education	3.62 (1.05)	2 - 6	4.42 (1.32)	2 – 7	3.00 (0.98)	2-5
Paternal education	3.86 (1.51)	2 - 7	3.76 (1.70)	1 - 7	2.67 (1.52)	1-7
Shared book reading	-	-	45.81 (5.32)	34-56	45.00 (6.41)	30-53
Family literacy	9.96 (2.15)	5-14	10.43 (1.86)	6-14	9.54 (1.50)	6-13
Age began reading to child [a]	7.50 (9.52)	0 - 42	11.11 (8.08)	0-30	8.68 (5.67)	0-21

Note. [a] in months, [b] vocabulary in relation to children of the same age, M = 100, SD = 15. Maternal education; n = 29 (age controls), n = 24 (later-schooled group), n =26 (reading controls). Paternal education; n = 27 (age controls), n = 21 (later-schooled group), n =26 (reading controls). Family literacy and Shared book reading; n = 28 (age controls), n = 21 (later-schooled group), n =24 (reading controls). Age began reading to child; n = 30 (age controls), n = 19 (later-schooled group), n =25 (reading controls). All other variables; n = 30 (age controls), n = 30 (later-schooled group), n =33 (reading controls). Standardised vocabulary = British Picture Vocabulary Scale; Word reading = British Ability Scales 2 word reading test.

2.3.2 *Mean comparisons of reading-related skills between groups*

Table 2.2 shows descriptive statistics for the measures of reading-related skills. Raw vocabulary scores are reported in this instance to reflect the absolute vocabulary level of each group. ANCOVAs were performed to test for mean differences in reading-related skills between groups with maternal education co-varied. Data on maternal education level was missing for 16% of the overall sample (n = 14). Missing Values Analysis ("PASW Statistics, 17.0," 2009), indicated that these data were missing completely at random (MCAR), Little's MCAR test, $\chi^2(6) = 10.14$, $p = .12$. Therefore, imputation of missing values was undertaken using multiple regression techniques (Tabachnik & Fidell, 2007)[2].

Seven ANCOVAs and 12 pairwise comparisons were performed. Therefore, adaptive linear step-up procedures were adopted to control for false discovery rate (Benjamini, Krieger, & Yekutieli, 2006). Sixteen null hypotheses were rejected using the single linear step-up procedure at level 0.05 (overall probability of Type I error was held at p=.05). Sixteen were also rejected at the first stage of the two-stage procedure run at level 0.05/1.05. At the second stage the linear step-up procedure was used at level $(0.05/1.05) \times 19/(19-16)=0.301$, resulting in the rejection of 17 hypotheses with $p \leq .059$. Results of the ANCOVAs are reported in Table 2.2 while pairwise comparisons are reported below[3].

[2] Substitution with the group mean and deletion of cases with missing values was also performed. These two analyses led to the same pattern of results for the ANCOVAs (with adaptive linear step up procedures applied) as MVA using multiple regression. In each case, 17 null hypotheses were rejected.
[3] Additional ANCOVAs were performed co-varying word reading (as well as maternal education level) for those children in the later-schooled (n = 13) and reading control (n = 11) groups whose scores were above 0 (1-5) on the BAS word reading test. The pattern of results obtained was virtually identical to the ANCOVAs without this co-variate and therefore are not reported.

Table 2.2

Means, standard deviations, and analysis of covariance (ANCOVA) results for measures of reading-related skills

		Age controls	Later-schooled group	Reading controls	ANCOVAs	
Variable	Max. Score	*M (SD)*	*M (SD)*	*M (SD)*	*F (2,89)*	r^2
Deleting sounds	20	16.40 (2.75)[a]	5.20 (2.30)	2.94 (2.16)[b]	272.5**	.86
Blending sounds	20	14.83 (2.38)[a]	6.80 (3.65)	3.27 (3.65)[b]	113.0**	.72
Letter-sound knowledge	26	-	10.97 (5.74)	15.88 (6.24)	7.3[c]**	.15
Vocabulary	168	88.47 (8.49)	84.77 (12.95)	53.91 (10.93)[b]	87.9**	.68
Recalling sentences	78	38.20 (10.22)	35.27 (11.17)	18.24 (6.85)[b]	37.5**	.48
Nonword repetition	18	10.23 (2.16)	11.17 (2.17)	7.48 (1.58)[b]	26.2**	.40
Visual-verbal learning	54	50.30 (3.79)[a]	45.37 (7.74)	39.27 (9.28)[b]	16.12**	.29

Note. $r^2 = \frac{t^2}{t^2 + df}$; [a] = schooling effect, $p \leq .059$, [b] = age effect, $p \leq .059$, [c]df =1,60; n = 30 (age controls), n = 30 (later-schooled group), n = 33 (reading controls). All means are for raw scores. Internal consistency reliabilities (alphas) are provided in the method section. Deleting sounds = Elision subtest of the Comprehensive Test of Phonological Processing; Blending sounds = Blending words subtest of the Comprehensive Test of Phonological Processing; Vocabulary = British Picture Vocabulary scale; Recalling sentences = subtest of the Clinical Evaluation of Language Fundamentals – 3/UK; Nonword repetition = subtest from the Comprehensive Test of Phonological Processing.

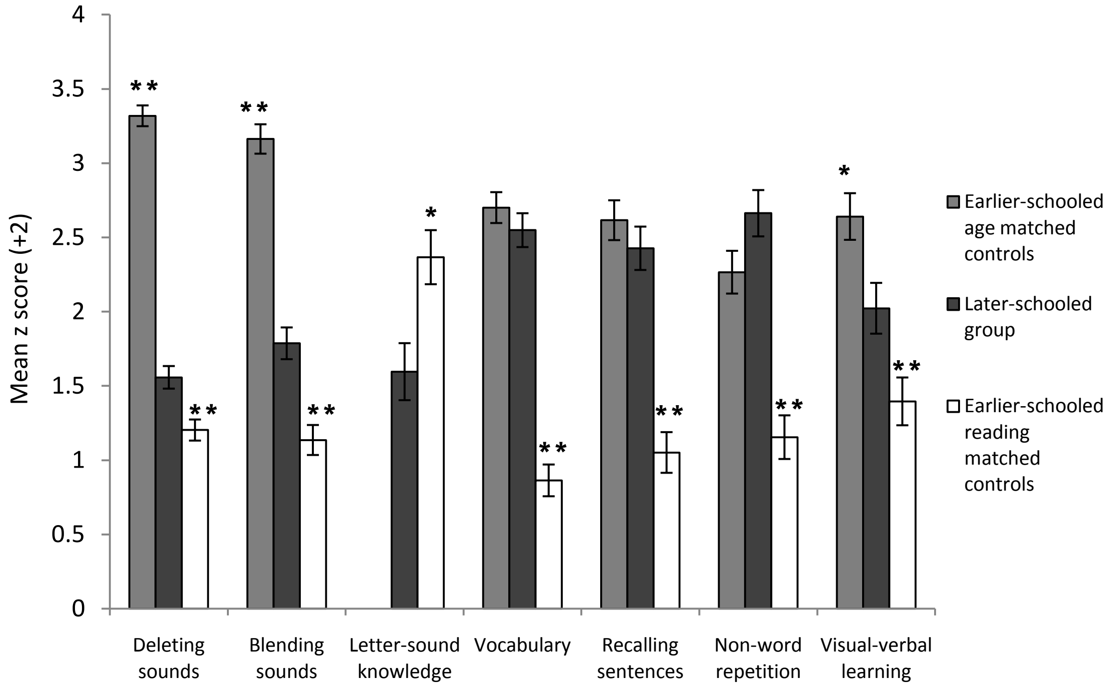
* $p < 0.05$, ** $p < 0.01$

Figure 2.1 displays the mean comparisons graphically. A higher level of performance in the later-schooled group compared to the reading controls indicates an age effect. Significant age effects were found for deleting sounds, $t(89)= 3.37$, $p <.01$, *r*

= .34; blending sounds, $t(89) = 3.78$, $p < .01$, $r = .37$; vocabulary , $t(89) = 10.31$, $p < .01$, $r = .74$; recalling sentences, $t(89) = 6.52$, $p < .01$, $r = .57$; non-word repetition, $t(89) = 6.85$, $p < .01$, $r = .59$; and visual-verbal learning, $t(89) = 2.66$, $p < .01$, $r = .27$. The reading controls significantly out-performed the later-schooled group on letter-sound knowledge, $t(60) = 2.71$, $p < .01$, $r = .33$.

Better performance in the age controls compared to the later-schooled group indicates a schooling effect. Significant schooling effects were found for deleting sounds, $t(89) = 17.15$, $p < .01$, r =.88; blending sounds, $t(89) = 9.43$, $p < .01$, $r = .71$; and visual-verbal learning, $t(89) = 2.64$, $p < .05$, $r = .27$. There were no significant effects of schooling on vocabulary, $t(89) = 1.04$, $p = .30$, $r = .11$, and recalling sentences, $t(89) = 1.01$, $p = .32$, $r = .11$. On the non-word repetition test, the later schooled group outperformed the age controls, $t(89) = 1.92$, $p = .059$, $r = .20$. However, low reliabilities for this task mean that this result should be treated with caution.

Figure 2.1. Mean levels of reading-related skills in each group



Note. Scores are adjusted for maternal education level. Scores are standardised to a mean of 2 and a standard deviation of 1. Error bars denote standard error. *n* = 30 (later-schooled group); *n* = 33 (earlier-schooled reading controls); *n* = 30 (earlier-schooled age controls)

* p<.05, ** p<.01 (all comparisons are with the later-schooled group).

2.3.3 *Phoneme and syllable awareness*

On both the blending sounds and deletion tasks, the first three items tested the ability to manipulate syllables and the next five tested the ability to manipulate phonemes. Therefore, data were re-coded as either 1 = Can delete phonemes (scored ≥ 3 out of 5) or 0 = Cannot delete phonemes (scored ≤ 2 out of 5). The same coding strategy was applied to the blending phonemes part of the blending task. The variables were then re-analysed as dichotomous to examine differences between groups.

All of the age control group could delete and blend phonemes compared to 46.7% and 66.7% of the later-schooled group, respectively. Differences between these two groups (schooling effect) were significant for deletion, $\chi^2(1) = 21.8$, $p < .01$, and blending, $\chi^2(1) = 12.0$, $p < .01$. In the reading control group, 12.1% of the children could delete phonemes while 24.2% could blend phonemes. Differences between the later-schooled and reading control group (age effect) were significant for deletion, $\chi^2(1) = 59.2$, $p < .01$, and blending, $\chi^2(1) = 11.5$, $p < .01$.

Next, data from the first three items, which measured syllable awareness, were analysed using a similar coding strategy; 1 = Can delete/blend syllables (scored ≥ 2 out of 3) and 0 = Cannot delete/blend syllable (scored ≤ 1 out of 3). All of the later-schooled children and age controls could delete and blend syllables compared to 81.8% and 48.5% of the reading control group respectively. A significant age effect was shown in both cases, $\chi^2(1) = 6.0$, $p < .05$ (deletion), and $\chi^2(1) = 16.4$, $p < .01$ (blending).

2.3.4 *Relationship between vocabulary and phonological awareness*

Correlations among all reading-related skills are shown in Tables 2.3 and 2.4. Deleting and blending sounds had non-significant correlations with vocabulary in the later-schooled and age control groups (r =.14-.22) whereas correlations between vocabulary and the phonological measures were moderate and significant in the reading control group (r =.48-.53). To determine whether the contribution of vocabulary to variance in phonological awareness differed between groups, hierarchical multiple regressions were performed on the combined sample (n = 93). Because we wished to assess the relationship with phonological awareness as a unitary construct, composite scores were calculated by adding the two phonological awareness tasks together (deleting and blending sounds). Group was dummy coded as two variables with the later-schooled group as the reference category (the group to which the other two were compared). Vocabulary and the two group variables were entered in the first step, one of the interaction terms was entered in the second step, and the other interaction term was entered in the third step (alternated so that each of the interaction terms was included last). The regressions confirmed the pattern of results suggested from the correlations. There was a significant interaction between vocabulary and group, $\Delta R^2 = .01$, $p < .05$, when the later-schooled group was compared to the reading controls, and a non-significant interaction, $\Delta R^2 = < .01$, $p = .78$, when the later-schooled group was compared to the age controls.

Table 2.3

Correlations between measures of reading-related skills in the later-schooled group and earlier-schooled reading matched controls

Variable	1	2	3	4	5	6	7
1. Deleting sounds	-	.52**	.32	.48**	.43*	.36*	.38*
2. Blending sounds	.51**	-	.52**	.53**	.30	.37*	.47**
3. Letter-sound knowledge	.67**	.45*	-	.47**	.41*	.29	.16
4. Vocabulary	.22	.04	.40*	-	.33	.23	.64**
5. Recalling sentences	.23	.15	.48**	.75**	-	.49**	-.13
6. Non-word repetition	.15	.32	.22	.45*	.50**	-	.03
7.Visual-verbal learning	.26	.22	.63**	.37*	.46*	.33	-

Note. Correlations are Bivariate (Pearson's r). Earlier-schooled reading controls are shown above the diagonal (*n* =33), later-schooled children below the diagonal (*n* =30).

* $p < 0.05$ (2 tailed), ** $p < 0.01$

Table 2.4

Correlations between reading-related skills in the earlier-schooled age matched control group

Variable	1	2	3	4	5	6	7
1. Deleting sounds	-						
2. Blending sounds	.41*	-					
3. Vocabulary	.14	.13	-				
4. Recalling sentences	.49**	.23	.56**	-			
5. Non-word repetition	.64**	.54**	.37*	.50**	-		
6. Visual-verbal learning	-.10	.31	.13	.07	.23	-	
7. Word reading	.62**	.35	.49**	.63**	.61**	.09	-

Note. Correlations are Bivariate (Pearson's r), $n = 30$

* $p < 0.05$ (2 tailed), ** $p < 0.01$

2.4 Discussion

The current study assessed the roles of age and schooling on the development of seven reading-related skills by comparing three groups of children differing in either exposure to formal reading instruction or chronological age. There were age effects, but not schooling effects, on vocabulary and short-term memory measures. On the visual-verbal learning measure and the phonological awareness tasks, there were both age and schooling effects. On the letter sound knowledge measure, the younger, reading level controls outperformed the later-schooled children. Finally, hierarchical multiple regressions revealed that the association between vocabulary and phonological awareness was significantly stronger in the younger reading control group compared to the older groups.

The later schooled children showed similar scores to the age matched controls on vocabulary and recalling sentences (and performed better on the nonword repetition), while both groups outperformed the younger group. This indicates the importance of age-related factors, and the relative unimportance of schooling in the development of receptive vocabulary and verbal memory skills. The non-significant effect of schooling on vocabulary is consistent with previous research suggesting that vocabulary is not significantly affected by exposure to formal instruction during early childhood (Christian, et al., 2000; Frazier and Morrison, 1998). Yet it conflicts with the hypothesis that reading causes vocabulary increases over time (Stanovich et al., 1986). It may be that this age control group is not yet advanced enough in reading for Matthew effects to be evident. Alternatively, it could be that the later-schooled children encountered a wide range of vocabulary as part of the Steiner curriculum, which diminished the comparative advantage incurred by the age control group through reading. Finally, the relative lack of schooling effects on the short-term verbal memory tasks may be due to a link between the development of vocabulary and phonological memory (Gathercole, et al., 1992; Metsala & Walley, 1998).

On a test of visual-verbal paired associate learning, there were both age and schooling effects. This task mimics the process of acquiring sight words in reading, and therefore it could be expected to be related to reading level. In the Morrison et al.,

(1995) study, the ability to recall the names of pictures (a visual-verbal paired associate task) was enhanced by formal instruction during first grade, but in contrast to our research, no age effect was found. This difference in results is most likely due to the larger age range covered by the current investigation (3 years compared to 1 year), and therefore more experience of visual-verbal mapping activities such as drawing and being read to.

Traditionally, it has been assumed that syllable awareness is primarily dependent upon age-related processes prior to learning to read, while phoneme awareness is dependent on formal literacy instruction (e.g., Goswami & Bryant, 1990). In the current study, both age and schooling effects were found on two explicit phoneme awareness tasks, indicating that this is somewhat of an over-simplification. A larger proportion of the later schooled compared to reading control children demonstrated phoneme awareness (a half compared to a tenth on the deletion task). There was also an age effect for syllable awareness. It is likely that age-related processes such as greater exposure to rhyming games, music and poetry (see Fazio, 1997a; Fazio, 1997b) led to better phonological skills in the later-schooled children. Ceiling levels of phoneme awareness in the age control group were probably due to the reciprocal relationship between reading and PA (e.g., Wagner, et al., 1994). Our findings are in line with previous research which shows an age effect on phoneme awareness prior to formal instruction in reading and a strong schooling effect once reading tuition has begun (Bentin, et al., 1991; Morrison, et al., 1995). They also provide support for the view that PA can, to a certain extent, develop in the absence of formal literacy instruction (Geudens & Sandra, 2003; Hulme, Caravolas, et al., 2005), and that this is more likely to happen in older than younger children (Mann, 1986).

All of the later-schooled children knew at least one letter sound, raising the possibility (as suggested by Castles & Coltheart, 2004) that these children used letter knowledge to help them solve the phoneme awareness tasks. If this was the case, however, the relationship was not straightforward: the later-schooled children showed significantly lower levels of letter knowledge than their reading level controls, yet had higher levels of phoneme awareness. While letter knowledge was significantly correlated with phoneme awareness within each group, there was clearly not a direct relationship such that learning, for example, ten letters conveyed the ability to solve a phoneme blending task. Therefore, letter knowledge does not fully account for the presence of phoneme awareness skills in the current sample.

Vocabulary was a significant predictor of phonological awareness for the younger, reading controls but not for the older later-schooled and age control groups. This difference was reflected in a significant interaction term between group and vocabulary (later-schooled and reading controls) in the prediction of phonological awareness. Such a finding is consistent with Scarborough and Dobrich's (1990) theory that performance on vocabulary tasks is more dependent on phonological skills earlier compared to later in development. These findings imply that it is the vocabulary 'growth spurt' as occurs with age (Metsala & Walley, 1998), rather than the onset of formal literacy instruction (and corresponding growth in explicit phoneme awareness) that leads to a change in the relationship between the two variables. A possible explanation is that once the mental lexicon reaches a certain size, it no longer constrains the formation of detailed phonological representations. On this hypothesis, the younger children's phonological skills would be closely dependent on their vocabulary size, while the older children (with larger vocabularies) would have phonological skills relatively independent of their vocabulary size.

2.4.1 *Possible limitations and further research*

Age effects were seen on all of the tasks except letter knowledge. Our research does not tell us which aspects of these age effects caused the observed differences in skills: the groups differed both in length of exposure to and the nature of literacy-related activities in the home and at pre-school. It is the view of the authors that exposure to varied experience with oral language over time is the likely driving force behind the age effect, but within the current study it is not possible to prove this. For example, music, poetry and story-telling (frequently from the teacher's memory) form a large part of the Steiner curriculum (Steiner, 1919/1976). Future research may wish to investigate whether there are aspects of the Steiner curriculum which particularly promote the development of reading-related skills, and whether these experiences can be replicated in mainstream schools.

Of course, caution must be exercised in generalising the results found with Steiner educated children to English-speaking children in general. The Steiner (later-schooled) group in the current study came from more highly educated mothers than average, and attended a fee-paying school, probably indicating high socio-economic status. However, there are some reasons to be confident about generalisability: the children demonstrated average vocabulary levels for their age and maternal educational level was not significantly associated with the variables tested. Additionally, this lack of association gives us confidence in the results despite imputation of missing values for maternal education level.

Finally, this research raises a few issues of methodology. For example, it could be argued that the younger children did not understand the phonological tasks and that the later-schooled group were more responsive to an assessment situation. However, given that the majority of children in both groups could delete syllables (within the same task), we can be fairly confident that the poor performance of the younger children was not an effect of lack of task understanding. The later-schooled children also did not have more experience of testing situations; Steiner schools discourage formal assessments, particularly in children under the age of seven. Furthermore, the superior performance of the reading controls on the letter knowledge task suggests that the younger children were well-motivated and able to concentrate sufficiently.

2.4.2 *Conclusions and implications*

Previous research has typically confounded age with length of formal schooling, leaving it uncertain whether developmental changes in reading–related skills are due solely to increased exposure to reading instruction or whether age-related factors also play a role. Our results suggest that exposure to formal schooling from a young age does not necessarily lead to advantages in the development of vocabulary and verbal memory, but that age-related processes may play an important role. It is important to note that these findings do not mean that vocabulary and memory skills need not be taught at school; simply that the curriculum as it currently stands does not seem to lead to benefits in these areas. Second, the results show that both age-related processes and literacy instruction influence the development of phonological awareness. Importantly, we found evidence that phoneme awareness can develop in the absence of measurable reading ability and that this is more likely to happen in older than younger children.

Finally, it is a reasonable step to assume that superior reading-related skills at the onset of formal schooling would lead to faster initial progress in reading, though of course this is likely to be mediated by the type of instruction the children receive. Chapter 3 gives the results of a longitudinal study following the later-schooled and reading control children during their first two years of reading tuition to assess the relative roles of initial reading-related skills and method of instruction on progress in early literacy.

3 The development of early literacy in children educated earlier compared to later in childhood

Abstract

Steiner-educated children begin learning how to read later in childhood and have better reading-related skills than standard-educated controls at the onset of instruction. But do these differences lead to faster progress in early literacy? Thirty later-schooled children (age 7-9) were compared to thirty-one earlier-schooled controls (age 4-6) during their first two years of formal reading instruction. There were no significant differences between groups in word reading at the end of the first and second year or reading comprehension at the end of the second year; however, the earlier-schooled group outperformed the later-schooled group on spelling at the end of both years. The later-schooled children maintained an overall lead in phonological deletion while letter knowledge and blending skills were equivalent in both groups by the end of the first year. The good progress of the younger children was attributed to more consistent and high quality phonics instruction.

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3.1 Introduction

In chapter 2, it was shown that Steiner-educated 7-8 year olds (later-schooled group) had significantly superior reading-related skills compared to a matched group of standard educated 4-5 year olds (earlier-schooled group) at the onset of formal literacy instruction. Age-related factors such as maturational processes and informal exposure to language were highlighted as the main driving force behind the development of these skills, all of which have been shown by previous research to be predictive of early reading ability. Therefore, it is a small step to predict that the later-schooled group will make faster initial progress in reading than their younger counterparts in standard education. For example, they may be more able to understand teaching because they have better language skills. These skills in addition to greater general physical and emotional maturity may allow the older later-schooled children to benefit more readily from reading tuition. To test the validity of this prediction, we measured the development of reading and spelling skills in the two groups during the first two years of formal reading instruction. Differences in the quantity and quality of literacy instruction between the two groups were also assessed. The results are interpreted within the context of research on the effect of age as well as different instructional methods on the development of early literacy.

3.1.1 *Age and schooling effects on early reading development*

School entry age in the UK is defined as ‘the year in which the child turns five’, meaning that most children are, on average, four and a half when they begin Reception. There is concern among parents and practitioners in Britain that four is too early an age for children to begin formal schooling (Alexander, 2009; School starting age - formal teaching versus play-based learning," 2009). More specifically, a lot of parents are concerned about the early onset of reading instruction (e.g., Fisher, 2000; Mcinnes, 2002). The view underlying these concerns is that children of this age are not developmentally ready to start reading and that they would benefit instead from more time spent on play and oral language development (Blenkin, 1994; Fisher, 2000; Juel, et al., 2003). Indeed, one of the key recommendations of the recent ‘Cambridge Primary review’ (a comprehensive review of primary education in the UK), is to delay the onset of formal teaching in the UK until the age of 6-7, as is currently practised in most other European countries (Alexander, 2009; Bertram & Pascal, 2002). Educationalists believe that this would lead to long-term social and behavioural benefits, as children would not be ‘put-off’ learning by being pressurised to perform at too young an age, whilst preserving standards in the long-term (Alexander, 2009). However, much of this conjecture is based on anecdotal evidence rather than empirical findings. The current study provides an opportunity to examine whether a later start to reading instruction leads to benefits for achievement in the short-term using a controlled comparison of younger and older beginning readers within the UK.

Evidence from cross-cultural comparisons and studies using the cut-off design supports the idea that there is an age effect in early literacy. The PIRLS study (Progress in International Reading Literacy Study) in 2006 showed that children in countries which start formal schooling at a later age (6 or 7), perform as well as and frequently better than British children at reading in primary school. The study compared reading comprehension skills in children during their fourth year of formal schooling in 40 countries across the world. England was ranked 19th while all the countries which ranked higher began formal schooling at a later age than in the UK, including Canada, another English speaking country (Mullis, et al., 2007). The results point to a possible age effect in the development of reading comprehension skills. However, a causal link cannot be made due uncontrolled cultural, educational and linguistic differences between the countries involved. For example, it has been shown that children educated in Welsh (a transparent orthography) learn to read at a faster rate and have better phoneme awareness skills during the first three years of school than their peers who were educated in English (a deep orthography) (Spencer & Hanley, 2003, 2004).

Seymour and colleagues, (2003) looked more closely at the development of decoding skills in speakers of English and 12 other languages. Danish children (who begin school at age 6), have an orthography that is similar in complexity to English. Results showed that the Danes made significantly more progress in word and nonword reading by the end of their first school year than the English-speaking children who began at age 5. One possibility is that the older age of the Danish children facilitated their acquisition of reading at this early stage, although a more controlled study on speakers of the same language would be necessary to determine this.

Finally, studies have shown that older pupils typically outperform younger pupils in the same year group on measures of early literacy. In an recent review, 10 out of 12 studies found that the oldest pupils in a year had better reading and related skills than the youngest pupils in the same year between the ages of 5 and 14 (Sharp, et al., 2009). Similar results were found for studies using the cut-off design which compared groups carefully matched on background variables (Crone & Whitehurst, 1999; Morrison, et al., 1997). However, it should be noted that those which have compared age and schooling effects (e.g, by adding a third group of the oldest children from the year below) have consistently found a greater effect of schooling compared to age. For example, Crone and Whitehurst, (1999) found that the effect of one year's additional schooling in First Grade was 4 times stronger than the effect of 10 months superiority in age on measures of early literacy. We predict the age effect in the current study to be larger than that found in cut-off studies due to the fact that the later-schooled children are a full 3 years older than controls.

3.1.2 *The effect of different instructional methods on early reading*

Aside from the age difference in beginning formal reading instruction, the Steiner method of teaching reading differs in many ways to the standard method in the UK. This is another factor, in addition to age, which will impact upon the progress made by the two groups investigated in the current study. Since the 1960s, classroom studies of reading methods have consistently shown better results for early phonics instruction compared with instruction emphasizing meaning at the level of words and sentences (e.g., Bowyer-Crane, et al., 2008; National-Reading-Panel, 2000; Rayner, et al., 2001; Torgesen, Morgan, & Davis, 1992). Therefore, although both groups in the current investigation experienced whole-language methods as well as phonic work, a key focus will be the different ways in which Steiner and standard schools teach phonics and the differing amounts of time spent on this activity.

At Steiner schools, children are taught phonics in a way that bears similarities to the analytic approach (Rose, 2006). Analytic phonics involves teaching children letter sounds in the context of words that they have been taught to recognise by sight; letters are taught first in the initial position of words (onset) before attention is drawn to letters in later positions. In Steiner classrooms, games are played during which children have to guess which words begin with a certain letter. Pictures of each letter are surrounded with drawings of words which begin with the same sound or name. Also, alliterative verses are taught e.g., ‘The fast flying bird flew’ (Bus & Kruizenga, 1986; Rawson & Richter, 2000; Steiner, 1919/1976). With regard to instructional time, a unique ‘teaching block’ timetable is followed at Steiner schools. Literacy is taught during the ‘main lesson’ (the first 2 hours of every day) in blocks lasting 3-4 weeks, interspersed with Numeracy blocks of equal length (Schwartz, 2009), during which the children receive no literacy tuition.

On the other hand, standard schools in the UK currently teach phonics using a synthetic approach (Rose, 2006). In contrast to the analytic approach, synthetic phonics focuses on phonemes in all positions of a word from the start, and how to blend these sounds. Children are taught to segment words (phonemic analysis), then blend these sounds from left to right (phonemic synthesis). Programs typically prescribe 20 minutes a day of phonic work during which all 40+ grapheme-phoneme correspondences in the English language are introduced in a gradual manner ("Letters and Sounds: Principles and practice of high quality phonics," 2007). Synthetic phonics has been shown to be more effective than analytic phonics (Johnson and Watson, 2004) with particular advantages for spelling (Bowyer-Crane, et al., 2008; Bradley & Bryant, 1983). This research predicts the opposite pattern of results from the age effect literature; that the earlier-schooled group (due to being exposed to synthetic phonics) will make faster progress than the later-schooled group in word-level literacy.

3.1.3 *Previous research on literacy in Steiner schools*

One study prior to this one has empirically investigated early reading acquisition in Steiner-educated children. Bus and Kruizenga, (1986) tested 125 children from the first three ‘post-Kindergarten’ years of a Steiner school in the Netherlands (Classes 1-3, 6-9 years old). At the end of the first year, only 5% of children achieved an accuracy level of 80% or more on a word reading test, in contrast to 85% of children in a standard Dutch primary school (Bus, 1984). Furthermore, at the end of Class 2 (age equivalent to the first year of formal reading instruction in the current study), 20% of the Steiner children could still not effectively decode simple CV, VC and CVC words. The authors conclude that the Steiner method of teaching reading is less effective than standard Dutch tuition, particularly for less able students.

Our study builds on the work of Bus & Kruizenga, (1986) through the addition of a matched control group and longitudinal follow-up. By following the literacy progress of a group of Steiner-educated children (later-schooled group) and a group of standard-educated children (earlier-schooled group) during the first two years of formal schooling, we will be able to make a fairer assessment of the relative progress of children within the Steiner system.

Two main questions are addressed:

1. Do later-schooled children make better progress than earlier-schooled children in reading and spelling during the first two years of formal reading instruction?
2. How does the development of phonological awareness and letter-knowledge compare between earlier and later-schooled beginning readers?

3.2 Method

3.2.1 *Participants*

The same sample of children was used as in Chapter 2. These were thirty older children recruited from two Steiner schools (later-schooled group) and thirty-three younger children (earlier-schooled group) recruited from one standard school in the UK. Children were drawn from 3 classes at the Steiner schools (2 from the first school, 1 from the second school) and 2 classes at the standard school. The children in each group were pairwise-matched for standardised vocabulary (within 5 points) and group-matched for home literacy environment. All had no or minimal reading skills at Time 1 (≤ 5 on the BAS word reading test). See Chapter 2 for a full description of the schools and matching procedure.

There was approximately 3 years and 1 month difference in age between the two groups. At Time 1 the average age in the later-schooled group was 7;10 years, range 7;3 to 8;3 and in the earlier-schooled group it was 4;9 years, range 4;3 to 5;2. At Time 4, average age was 9;6 years, range 9;0 – 10;0 (later-schooled group) and 6;4 years, range 5;10 – 6;10 (earlier-schooled group).

The full sample (later-schooled n = 30, earlier-schooled, n =31) were tested at three time points over the course of one school year (Times 1 -3). Children were tested during the first year of formal reading instruction (beginning, middle and end) at intervals of approximately four months. A reduced sample (later-schooled, 19, earlier-schooled, 19) was tested again at the end of the second year (Time 4). Children in the earlier-schooled group were in the Reception class for the first year and Year 1 for the second year. Children in the later-schooled group were in Class 2 for the first year and Class 3 for the second year.

Subsequent to Time 1, data from two children were lost from the earlier-schooled group, one because he refused to complete the tasks at Time 3 and another because he was absent from school for a prolonged period of time during the second and third terms. This left complete data for sixty-one children (30 later-schooled, and 31 earlier-schooled). Comparison of background characteristics between the children than were and were not tested at T4 in each of the groups revealed no significant differences except a lower level of maternal education in the reduced earlier-schooled group at T4; $t(24)=2.17$, $p<.05$. See Tables 3.1 for a list of background characteristics.

Table 3.1

Background characteristics (samples at T1-3)

	Later-schooled		Earlier-schooled	
Variable	M (SD)	Range	M (SD)	Range
Age T1[a]	94.13 (3.65)	87 – 99	57.29 (3.94)	51-62
Age T2	97.83 (3.54)	91-103	60.52 (3.95)	54-66
Age T3	102.50 (3.49)	96-107	64.35 (3.95)	58-70
Standardised Vocabulary [b]	104.77 (10.96)	85 –126	105.26 (10.46)	89-131
Maternal education	4.42 (1.32)	2 – 7	3.00 (0.98)	2 - 5
Paternal education	3.76 (1.70)	1 – 7	2.65 (1.47)	1 - 7
Shared book reading at home	45.81 (5.32)	34-56	45.00 (6.41)	30-53
Family literacy	10.43 (1.86)	6-14	9.54 (1.50)	6-13
Age began reading to child[a]	11.11 (8.08)	0-30	8.68 (5.67)	0-21

Note. [a] in months, [b] vocabulary in relation to children of the same age, M = 100, SD = 15. Standardised vocabulary = British Picture Vocabulary Scale. Maternal education; *n* = 24 (later-schooled), *n* =26 (earlier-schooled). Paternal education; *n* = 21 (later-schooled), *n* =26 (earlier-schooled). Family literacy and Shared-book reading at home; *n* = 21 (later-schooled), *n* =24 (earlier-schooled). Age began reading to child; *n* = 19 (later-schooled), *n* =25 (earlier-schooled). All other variables; *n* = 30 (later-schooled), *n* =31 (earlier-schooled).

3.2.2 *Design and Procedure*

Children were tested individually by the same experimenter in a quiet corner of the school. Time 1 tasks were administered during September and October (later-schooled group) and November and December (earlier-schooled group). Time 2 data were collected four months later and Time 3 data 4 months after Time 2. Finally, Time 4 data were collected in June (Steiner group) and July (standard group) of the following year. Tasks were presented in a fixed order, with the phonological and literacy tasks interspersed to maintain interest. Tasks administered at each time point are listed below.

Time 1. Word reading, letter-sound knowledge, deleting and blending sounds, receptive vocabulary, recalling sentences, non-word repetition and visual-verbal learning. In addition, a home literacy environment questionnaire was sent home for parents to complete. (Time 1 measures and results are described in Chapter 2)

Time 2. Word reading, non-word reading, letter-sound knowledge, deleting and blending sounds. In addition, the teachers (n =5) were given a questionnaire about the quantity and type of reading instruction that the children were receiving during Class 2 and Reception (first year of formal reading instruction).

Time 3. Word reading, non-word reading, spelling, letter-sound and letter-name knowledge, deleting and blending sounds.

Time 4. Word reading, spelling, The York Assessment of Reading for Comprehension.

3.2.3 *Materials*

Literacy tasks

Letter-sound knowledge. Each of the 26 lower case letters were presented individually on cards in random order. Children were asked to pronounce the sound of the letter. If they replied with the letter name, they were asked if they knew what the letter sound was.

Letter-name knowledge. Same as above except that children were asked to pronounce the name of the letter, not the sound. If they replied with the letter sound, they were asked if they knew what the letter name was.

Word reading. Test was from the British Ability Scales 2 (BAS) (Elliot, Smith, & McCulloch, 1996). Children were asked to read as many words as possible from a list. The test was discontinued after 8+ incorrect answers in a block of ten. Sample-specific reliabilities for this task at T3 were high[4]: Later-schooled, Cronbach's $\alpha = .97$; earlier-schooled, $\alpha = .96$.

Non-word reading. Children's ability to decode non-words was tested using the non-word reading test from Seymour et al., (2003). 18 monosyllabic and 18 bisyllabic words were presented in lists vertically arranged on two A4 sheets. Words were presented in clear lower case font and could all be decoded using simple letter-sound correspondences. Children were told that they would be shown some nonsense words which they could 'sound-out' and then 'put together' to make the word. If children replied using the letter name to denote a phoneme, they were asked to repeat using the letter sound instead. Corrective feedback was provided for the first six items and the test was stopped after six consecutive incorrect responses (for the monosyllabic words) and four incorrect responses (for the bisyllabic words).

Spelling. Spelling was measured using the British Ability Scales 2 spelling test. Children were asked to spell individual words in pencil on a numbered answer sheet. The words were presented orally by the experimenter within a sentence and repeated if

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[4] Sample-specific reliabilities were not calculated for word reading at Times 1 and 2 due to the large number of children in both groups who ≤5 in both groups (T1, 100%, T2, 62%).

necessary. Encouragement was given to guess the spelling of unfamiliar words. All children began with item 1 but moved to the next block if they spelt the first two words correctly. The test was discontinued if they got 8+ wrong in a block of 10. Sample specific reliabilities for this task at T3 were good: Later-schooled, Cronbach's α = .88; earlier-schooled, α = .93.

The York assessment of reading for comprehension. Children were asked to read two short passages of text as part of the York Assessment of Reading for Comprehension (Snowling, et al., 2009). Passages of an appropriate level were selected based on the child's score on the word reading test. Scores for reading accuracy, reading rate and reading comprehension were calculated based on this assessment. The number of errors (mispronunciations, substitutions, refusals, additions, omissions and reversals) was used to calculate reading accuracy, average number of words read per second led to a reading rate score and number correct out of 8 comprehension questions resulted in a comprehension score. In each case, raw scores were converted to Rasch-based ability scores and then averaged across the two passages to obtain a final score. Only children reading passages of difficulty level 1 and above were timed, leaving reading rate data for 11/19 Steiner children and 17/19 standard children.[5]

Phonological tasks

Children's ability to segment and blend sounds at the level of the syllable and phoneme was measured using the elision and blending tests from the Comprehensive Tests of Phonological Processing (Wagner, et al., 1999).

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[5] Sample-specific reliabilities were not calculated for the York assessment of reading for Comprehension due to the low number of children in each group who read the same passages.

Teacher questionnaire.

A questionnaire adapted from the one used by Shapiro & Solity (2008) for the Early Reading Research Project was completed by each of the teachers involved in the current study. Children came from 5 classes, each with 1 teacher (First Steiner school, *n* = 2; second Steiner school, *n* =1; standard school, *n* =2). The questionnaire consisted of 6 questions which focused on the amount of time devoted to and the nature of reading instruction given to the children during the first year of formal reading instruction. Responses to these questions were used to estimate the number of hours spent on 'reading activities' and phonic work in each class per week (see Appendix 2).

3.3 Results

A number of variables did not conform to the normal distribution. The two phonological tasks tended towards a bimodal distribution, probably due to the fact that they measured separable skills (deletion and blending at the syllable and phoneme level). Letter-sound knowledge tended towards a negative skew (ceiling effect) at Times 2 and 3, as did letter-name knowledge at T3 in the later-schooled group. The word and non-word reading measures had a tendency to be positively skewed (floor effects), especially in the later-schooled group. Due to the differing pattern of distributions across variables, groups and time points, it was decided not to transform the scores. All analyses were performed on raw scores, apart from the reading comprehension, accuracy and rate data which were converted to ability scores. There were no significant correlations between maternal education level in each group and any of the literacy measures, suggesting that this variable did not have a significant influence on literacy development for the current sample. Therefore, it was not co-varied during subsequent analyses.

3.3.1 *The development of literacy during the first year*

Table 3.2 shows means and standard deviations for the literacy measures at T1-3. Two-way mixed ANOVAs were conducted to determine the effect of time and group on the development of word reading. Time was entered as a 3 level within-subjects factor and group as a two level between-subjects factor. Mauchly's tests indicated that the assumption of sphericity had been violated for the main effects of time on word reading, $\chi^2(2) = 36.36$, $p < .001$. Therefore, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .68$).

Table 3.2

Means (and standard deviations) for the literacy measures (T1-3)

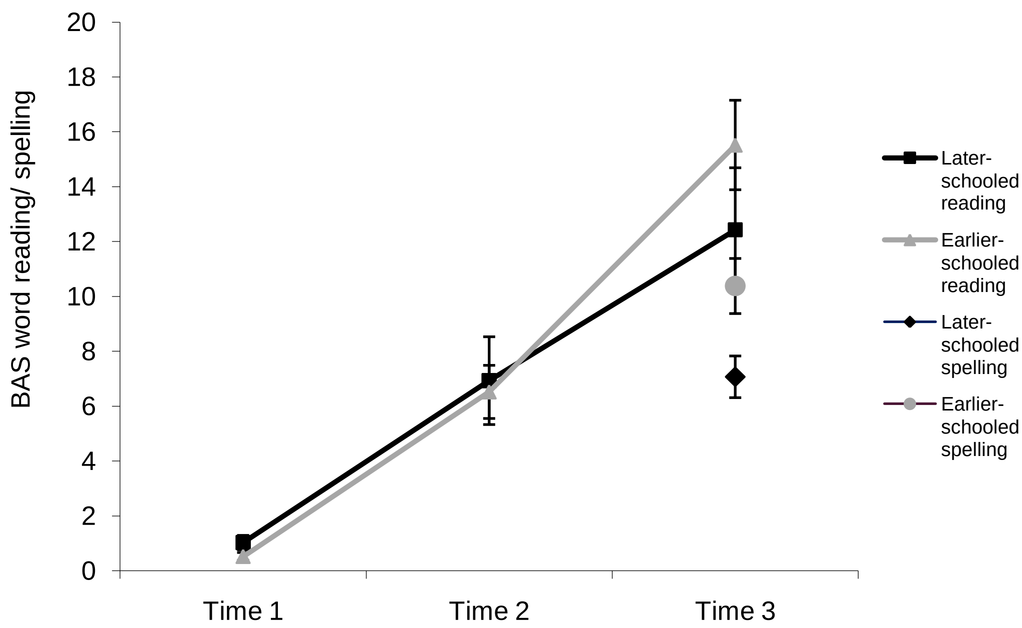
Variable	Max. score	Group	Time 1	Time 2	Time 3
Word reading	90	Later-schooled	1.03 (1.43)	6.93 (8.74)	12.43 (12.38)
		Earlier-schooled	0.52 (0.81)	6.45 (5.40)	15.29 (9.08)
Non-word reading	36	Later-schooled	-	8.33 (11.02)	12.97 (11.71)
		Earlier-schooled	-	7.55 (8.87)	14.90 (10.54)
Spelling	75	Later-schooled	-	-	7.17 (4.16)
		Earlier-schooled	-	-	10.68 (5.59)

Note. Later-schooled, n = 30; Earlier-schooled, n = 31; All scores are raw scores. Dashes indicate tasks not administered at an assessment period. Word reading = British Ability Scales 2 word reading test; Spelling = British Ability Scales 2 spelling test.

There was a main effect of time on word reading, $F(1.36, 80.50) = 83.43$, $p < .001$, but no main effect of group, $F(1,59) = 0.16$, p= .69, $r = .05$. Contrasts revealed that there was a significant increase in word reading between T1 and T2, $F(1,59)= 49.95$, $p < .001$, $r = .68$, and between T2 and T3, $F(1,59)= 78.37$, $p < .001$, $r =.76$. The overall interaction Group × Time was insignificant, $F(1.36,80.50) = 0.18$, $p = .18$. However, contrasts revealed that while the interaction was not significant between T1 and T2, $F(1,59) < .01$, $p =.98$, $r < .01$, there was a significant interaction between T2 and T3, $F(1,59)= 4.25$, $p < .05$, $r = .26$, indicating that the earlier-schooled children made significantly more progress in reading between the middle and end of the year than the later-schooled children.

On the spelling test at Time 3, there was a significant difference in spelling in favour of the earlier-schooled children at T3, $t(59)=2.78$, $p < .01$, $r = .34$. For the non-word reading test, there was no significant difference in scores at T3, $t(59) = .68$, $p =.50$, $r = .09$. Figure 3.1 shows the development of word reading over time and spelling at T3.

Figure 3.1. Growth in word reading skills and spelling at T3



Note. Later-schooled, *n* = 30; Earlier-schooled, *n* = 31; Error bars denote mean standard error.

A third (*n* =10) of the later-schooled group read 5 or less words on the reading test at the end of the year, compared to 12.9% (*n* = 4) of the earlier-schooled group. This was the limit originally set at T1 to indicate that a child was a non-reader. A Chi square test showed that this difference approached significance, $\chi^2(1)=3.60$, $p=.06$. Spelling was more normally distributed with 16.7% (*n*= 5) of later-schooled children who spelt 2 or less words correctly, compared to 9.7% (*n* =3) of the earlier-schooled group. This difference was not significant, $\chi^2(1)=0.65$, $p=.42$. Figures 3.2-3.3 show distributions for word reading and spelling in both groups for the full sample at T3.

Figure 3.2. The distribution of word reading scores at T3

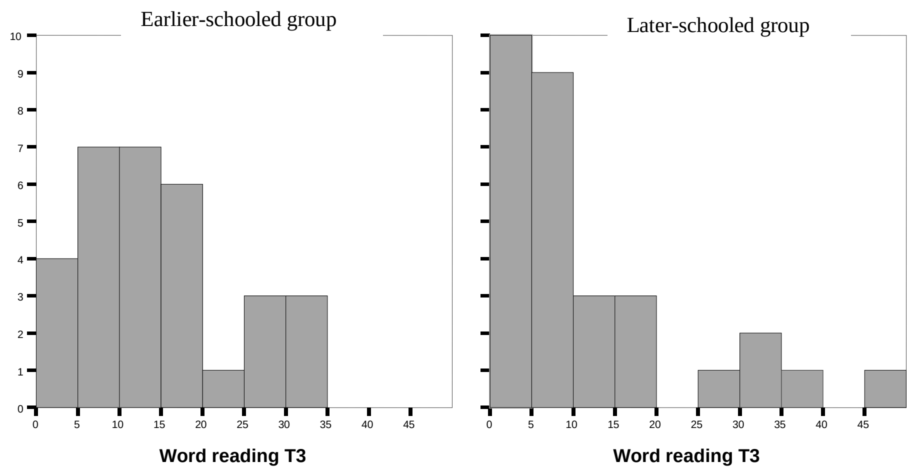
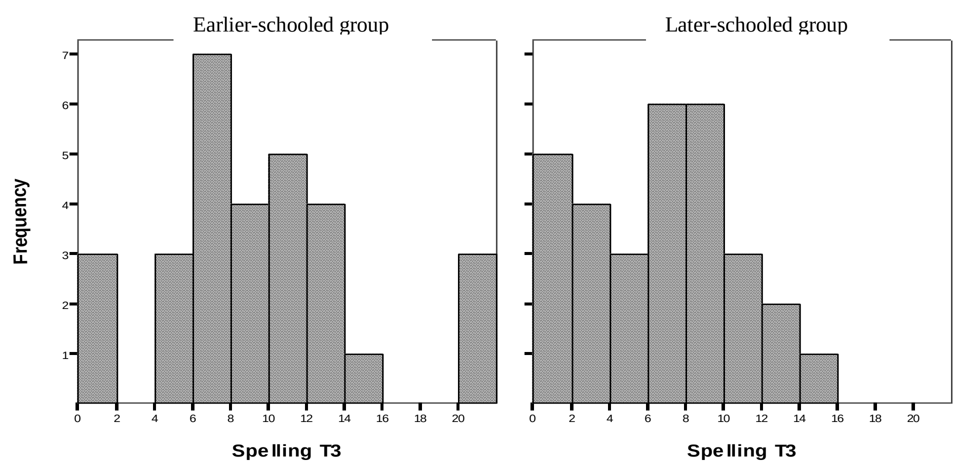


Figure 3.3. The distribution of spelling scores at T3



3.3.2 *Analysis of spelling errors*

In order to gain an idea of what spelling strategies the children were using, and whether this differed between the groups, an analysis of their spelling errors at T3 was conducted. The number of incorrectly spelt words was similar in each group (later-schooled: 254 errors, earlier-schooled: 246 errors). However, the number of words that the children attempted to spell was lower in the later-schooled group (469 later-schooled, 577 earlier-schooled); hence the higher number of correctly spelt words in the earlier-schooled group. Differences in the number of words attempted was mainly due to the ‘stop rule’ applied during the spelling test, whereby if 7+ items in a block of 10 were incorrectly spelt, then subsequent items were not administered. Spelling errors were classified as either phonetic or non-phonetic. Phonetic errors represented the same number of phonemes as in the target word, with at least the first phoneme producing an accurate pronunciation. For example, ‘dap’ for ‘down’ or ‘eet’ for ‘eat. All other errors were classified as non-phonetic.

The later-schooled children made on average 5.87 phonetic errors (*SD*=3.47) out of an average of 8.47 errors in total (*SD* = 3.13), while the earlier-schooled children made an average of 5.48 phonetic errors (*SD* =2.99) out of an average of 7.94 (*SD* =2.44); this difference was non-significant, $t(59)=0.46$, $p=.65$, $r=.06$. The result suggests that there was similar usage of phonetic strategies in each group at T3.

3.3.3 *Literacy at the end of the second year*

Table 3.3 shows means and standard deviations for the measures taken from the reduced sample at the end of the second year of formal literacy instruction (T4). Figure 3.4 displays the mean comparisons graphically. T-tests for independent samples were performed to test for significant differences between groups at T4. There were no significant differences in word reading, $t(36) = 0.14$, $p = .89$, $r = .02$; however (similar to T3), there was a significant difference in spelling in favour of the earlier-schooled children, $t(36)=2.62$, $p<.05$, $r = .40$. There were no significant differences in reading accuracy, $t(36) = 0.50$, $p=.62$, $r = .08$, reading rate, $t(26)=0.93$, $p = .36$, $r = .18$, and reading comprehension, $t(36)= 1.57$, $p=.13$, $r = .25$.

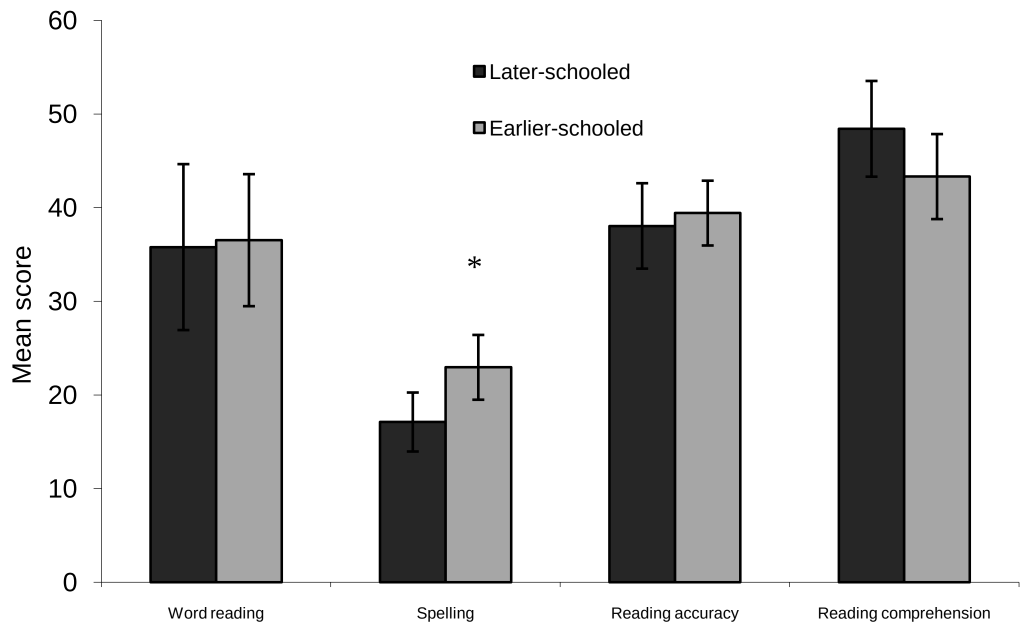
Table 3.3

Means (and standard deviations) for the literacy measures at T4

Variable	Max. score	Group	Score
Word reading	90	Later-schooled	35.79 (18.39)
		Earlier-schooled	36.53 (14.64)
Spelling	75	Later-schooled	17.11 (6.54)
		Earlier-schooled	22.95 (7.19)
Reading accuracy	90	Later-schooled	38.05 (9.45)
		Earlier-schooled	39.42 (7.17)
Reading rate	99	Later-schooled[a]	41.45 (22.45)
		Earlier-schooled[b]	34.59 (16.67)
Reading comprehension	93	Later-schooled	48.42 (10.59)
		Earlier-schooled	43.32 (9.42)

Note. Later-schooled, n = 19; Earlier-schooled, n = 19; ^{a}n = 11, ^{b}n = 17. Reading accuracy, rate and reading comprehension scores are ability scores. Word reading = British Ability Scales 2 word reading test; Spelling = British Ability Scales 2 spelling test; Reading accuracy, rate, and reading comprehension = York Assessment of Reading for Comprehension.

Figure 3.4. Mean levels of literacy skills at T4



Note. Error bars denote 95% confidence intervals. T4. Later-schooled, *n* =19; Earlier-schooled, *n* =19

* p<.05. ** p<.01.

3.3.4 *The development of phonological awareness and letter knowledge*

Two-way mixed ANOVAs were conducted to determine the effect of time and group on the development of phonological skills and letter knowledge during the first year. Time was entered as a 3 level within-subjects factor and group as a two level between-subjects factor. Mauchly's tests indicated that the assumption of sphericity had been violated for the main effects of time on letter-sound knowledge, $\chi^2(2) = 26.87$, $p < .001$, and deleting sounds, $\chi^2(2) = 11.03$, $p < .01$. Therefore, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .74$ for letter-knowledge and $\varepsilon = .85$ for deleting sounds).

Table 3.4 shows means and standard deviations for the letter-knowledge and phonological measures. Figure 3.5 shows growth in letter knowledge over time. There was a main effect of group on letter-sound knowledge with the earlier-schooled children performing significantly better than the later-schooled group, $F(1,59) = 17.98$, $p < .01$, $r = .48$. There was also a main effect of time, $F(1.47, 86.78) = 138.10$, $p < .01$ with a significant increase between T1 and T2, $F(1,59) = 192.21$, $p < .01$, $r = .87$, and T2 and T3, $F(1,59) = 20.60$, $p < .01$, $r = .51$. There was no significant interaction Group × Time, $F(1.47, 86.78) = 0.31$, $p = .67$, either between T1 and T2, $F(1,59) = 0.19$, $p = .66$, $r = .06$, or T2 and T3, $F(1,59) = 0.99$, $p = .33$, $r = .13$. There was a significant difference in letter-name knowledge at T3 in favour of the later-schooled children, $t(59) = 5.89$, $p < .01$, $r = .61$. Overall letter knowledge (sounds and names combined) was similar in each group at T3 (23.37 later-schooled, 24.81 earlier-schooled, $t(34.36) = 1.73$, $p = .09$, $r = .28$).

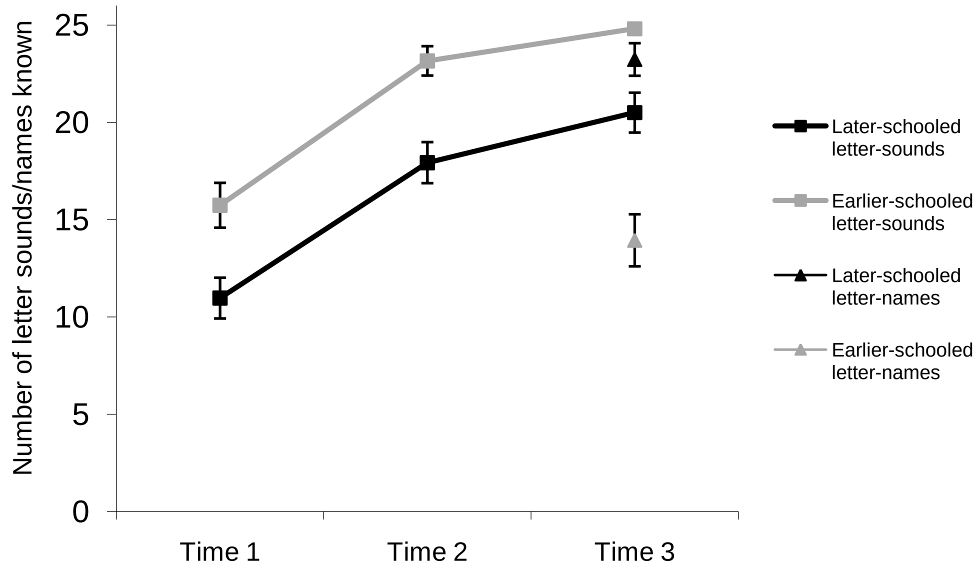
Table 3.4

Means (and standard deviations) for the letter knowledge and phonological measures at Times 1 -3

Variable	Max. score	Group	Time 1	Time 2	Time 3
Letter-sound knowledge	26	Later-schooled	10.97 (5.74)	17.93 (5.77)	20.50 (5.61)
		Earlier-schooled	15.74 (6.41)	23.16 (4.20)	24.81 (1.35)
Letter-name knowledge	26	Later-schooled	-	-	23.23 (4.58)
		Earlier-schooled	-	-	13.94 (7.45)
Deleting sounds	20	Later-schooled	5.20 (2.30)	6.70 (3.48)	7.80 (3.06)
		Earlier-schooled	2.77 (2.03)	4.19 (2.36)	6.13 (3.85)
Blending sounds	20	Later-schooled	6.80 (3.06)	10.23 (2.86)	11.30 (2.55)
		Earlier-schooled	3.23 (3.62)	7.68 (4.34)	11.29 (3.00)

Note. Later-schooled, $n = 30$; Earlier-schooled, $n = 31$.

Figure 3.5. Growth in letter knowledge over time

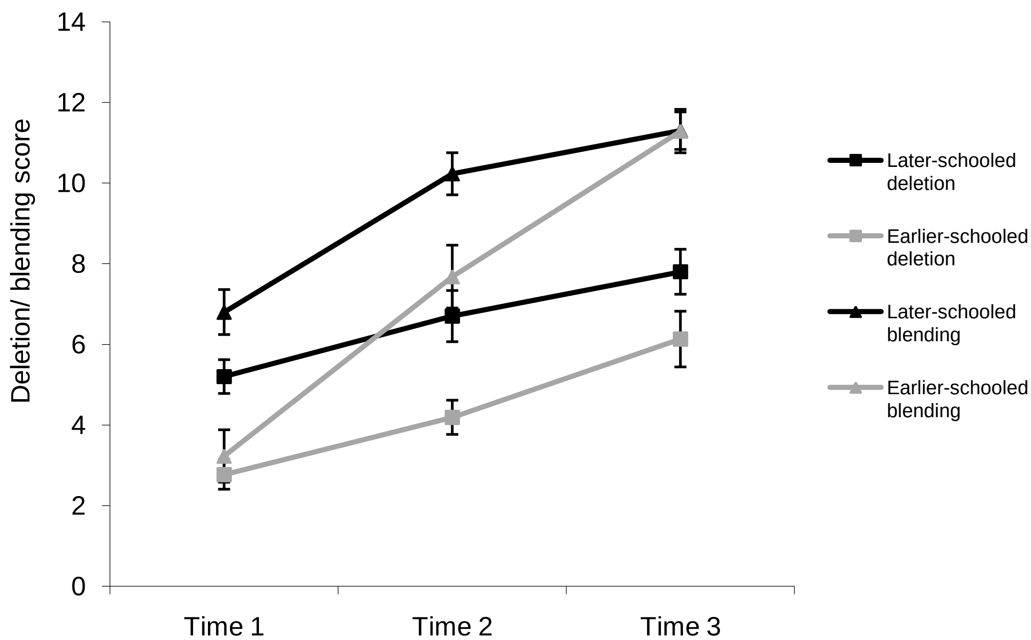


Note. Later-schooled, n = 30; Earlier-schooled, n = 31. Error bars denote mean standard error.

Figure 3.6 shows growth in the two phonological awareness measures over time. Overall, the later-schooled children performed significantly better than the earlier-schooled group on deleting sounds, $F(1,59) = 11.12$, $p < .01$, $r = .40$. There was also a main effect of time, $F(1.71,100.58) = 48.15$, $p < .01$, with significant increases in deletion scores between T1 and T2, $F(1,59) = 36.32$, $p < .01$, $r = .62$, and T2 and T3, $F(1,59) = 24.77$, $p < .01$, $r = .54$. However, there was no significant interaction Group × Time, $F(1.71, 100.58) = 1.15$, $p = .31$, either between T1 and T2, $F(1,59) = 0.03$, $p = .87$, $r = .02$, or T2 and T3, $F(1,59) = 1.88$, $p = .18$, $r = .18$.

Similarly, the later-schooled children performed significantly better than the earlier-schooled children on blending sounds, $F(1,59) = 7.54$, $p < .05$, $r = .33$. Again, time was also significant, $F(2,118) = 170.60$, $p < .01$, with increases in blending scores between T1 and T2, $F(1,59) = 110.73$, $p <.01$, $r = .81$, and T2 and T3, $F(1,59) = 58.76$, $p <.01$, $r = .71$. However, in contrast to the deletion scores, there was a significant interaction Group × Time, $F(2,118) = 14.26$, $p < .01$. Contrasts revealed that the interaction was not significant between T1 and T2, $F(1,59)= 1.85$, $p = .18$, $r = .17$, but there was a significant interaction between T2 and T3, $F(1,59)= 17.40$, $p <.01$, $r = .48$, with the earlier-schooled children making significantly more progress between the middle and end of the year than the later-schooled children.

Figure 3.6. Growth in phonological awareness over time



Note. Later-schooled, n = 30; Earlier-schooled, n = 31. Error bars denote mean standard error

3.3.5 *Attainment of specific phonological skills over time*

The two phonological tasks were re-analysed as categorical variables. This is because each task could be perceived as measuring two separate abilities; manipulation at the level of the syllable and phoneme. For the deleting sounds task, children scoring

≥5 were categorised as being able to delete phonemes, while those scoring <5 were classed as not having attained this skill. Similarly, those who scored ≥5 on the blending task were categorised as being able to blend phonemes, and so on (see chapter 2 for a detailed explanation of the scoring system). The percentage of children attaining these skills at each time point is shown in Table 3.5. This shows a steady increase in the attainment of phonological skills in both groups over time. The later-schooled children began with and maintained a higher number with the ability to delete and blend phonemes compared to their earlier-schooled counterparts, other than blending at T3 where virtually all children in both groups attained this skill.

Table 3.5

Percentage of children achieving deletion and blending skills

		Time1 (*n*)	Time 2 (*n*)	Time 3 (*n*)
Can delete	Later-schooled	46.7 (14)	66.7 (20)	86.7 (26)
phonemes	Earlier-schooled	9.7 (3)	32.3 (10)	58.1 (18)
Can blend	Later-schooled	66.7 (20)	96.7 (29)	100 (30)
phonemes	Earlier-schooled	22.6 (7)	67.7 (21)	96.8 (30)

Note. T1 percentages for the earlier-schooled group differ slightly to those reported in Chapter 2 due to an attrition of two children in this group between T1 and T3.

Chi square tests revealed that there were significant differences between the attainment of deletion skills in each group at each time point, T1, $\chi^2(1) = 10.38$, $p < .01$, T2 $\chi^2(1) = 7.22$, $p < .01$, and T3, $\chi^2(1) = 6.21$, $p < .05$. There were significant differences in the number of children who could blend phonemes at T1, $\chi^2(1) = 12.01$, $p < .01$ and T2

$\chi^2(1) = 8.63$, $p < .05$. Chi square analysis was not appropriate at T3 since all of the children in the later-schooled group could blend phonemes.

3.3.6 *The effect of time spent on literacy tuition*

Table 3.6 shows the results with regard to amount of time spent on literacy tuition in each of the 5 classes, as derived from the teacher questionnaires.

Table 3.6

Reading and spelling progress in relation to teaching time

Class	Weeks of instruction	Hours of reading activities per		Hours of phonic work per		Minutes of phonic work per word read at T3 M (SD)	Minutes of phonic work per word spelt at T3 M (SD)
		week	year	week	year		
Later-schooled							
1	12.5	5;00	62;30	1;15	15;40	116 (100)	220 (279)
2	13.0	4;00	52;00	1;40	21;40	291 (375)	180 (73)
3	12.0	1;00	12;00	1;15	15;00	232 (261)	344 (337)
Mean	12.5	3;20	42;12	1;24	17;25	218 (279)	243 (248)
Earlier-schooled							
4	22.5	2;30	56;20	1;40	37;30	190 (104)	271 (241)
5	22.5	2;30	56;20	1;40	37;30	373 (581)	357 (322)
Mean	22.5	2;30	56;20	1;40	37;30	278 (414)	313 (282)

Note. Class 1, n = 9; Class 2, n = 12; Class 3, n = 9; Class 4, n = 16; Class 5, n =15. Values are expressed as hours; minutes

There was substantial self-reported variation in the amount of time spent per week on 'reading activities' between the 3 Steiner teachers with the teacher of Class 3 spending only 1 hour a week on such activities compared to 5 hours in Class 1. Conversely, there was no self-reported variation between the two teachers at the standard school, who were following a prescribed national curriculum. Total time spent on reading activities, and total time spent on phonics across the year was higher in the standard group due to the greater number of weeks of active instruction (12.5 weeks in the Steiner group compared to 22.5 weeks in the standard group).

Non-parametric correlations (Spearman's Rho) showed that there was a significant correlation between minutes of phonic work per year a child received and both their word reading (.31, p <.05) and spelling score at T3 (.35, p <.01). Yet, there was no significant correlation between minutes of reading activity per year and word reading (.16, p =.23) and spelling (.16, p =.22). Mann Whitney tests comparing mean minutes of phonic work per word read/spelt showed that there was a non-significant difference between groups for words read, U= 341, p =.11, but there was a significant difference for words spelt with the earlier-schooled children needing more minutes of phonic work per word spelt than the later-schooled children, U =290, p <.05.

3.4 Discussion

This study compared the early literacy progress of later-schooled, Steiner-educated children and earlier-schooled, standard-educated children during the first two years of formal reading instruction. In word reading and reading comprehension, no group differences were found. In letter-sound knowledge and spelling, the earlier-schooled children out-performed the later-schooled children, although overall letter knowledge was equivalent in both groups. In phonological awareness, the later-schooled group showed better early deletion and blending skills, but by the end of the first year, the earlier-schooled group showed similar scores on the blending task. In other words, our hypothesis that the later-schooled group would make better progress was not supported.

The simplest explanation for this finding is that age and reading-related skills do not play a role in the development of reading and therefore it does not make a difference at what age you learn to read. However, this is unlikely given previous research showing how important these factors are (e.g., Lonigan, et al., 2000; Morrison, et al., 1997; Muter, et al., 2004). Therefore, we must look to an alternative explanation.

It is most likely that the later-schooled children did not make faster progress than the earlier-schooled group due to differences in the quality and/ or quantity of literacy instruction they received. First, the later-schooled children received substantially less instructional time on literacy than the earlier-schooled children. Classes in the later-schooled group spent on average 17½ hours on phonic work compared to 37½ hours in the earlier-schooled group. Consequently, amount of teaching time spent on phonic work per word read/ spelt was less in the later-schooled group, significantly so for words spelt. A possible explanation is that the superior reading-related skills and greater maturity of the later-schooled children (age-related factors) made them more receptive to the instruction that they received allowing them to make more progress per unit of teaching time than their younger counterparts.

Second, the ‘quality’ of phonics instruction varied between the two groups. The older group was taught via a method which bore similarities to the analytic phonics approach while the younger group was taught via a program of synthetic phonics. Previous research has shown that synthetic phonics is particularly effective at achieving fast initial progress in word-level literacy, with particular gains in spelling (Bowyer-

Crane, et al., 2008; Johnston & Watson, 2004). Such a result suggests that the later-schooled children did well to achieve similar progress to the earlier-schooled group in reading, despite not receiving this instruction. It was also noteworthy that an analysis of spelling errors showed that both groups used phonetic strategies to a similar extent when attempting to spell. In conclusion, when quality and quantity of phonics instruction is taken into account, it is likely that age-related processes were operating to 'help' the later-schooled group achieve comparable levels of literacy. However, in the absence of a comparison group of younger children exposed to the Steiner method of instruction (or vice versa), it is not possible to separate the effects of age and instruction in the present study.

The high proportion of later-schooled children scoring 5 or below on the word reading test (33.3%) is consistent with the results of the Bus & Kruizenga, (1986) study which found that 20% of Steiner-educated children still could not decode simple CVC words by the end of the Class 2. This result suggests that the Steiner method may be particularly ineffective for children with potential reading difficulties. Similarly, the relatively lower number of children in the earlier-schooled group to score 5 or below on word reading is consistent with the findings of Johnson & Watson, (2004) that the synthetic phonics approach incurs particular benefits for children at risk of reading difficulty, bringing them up to a level that is more in line with their peers compared to those receiving instruction in analytic phonics.

Finally, the finding that there was no significant difference in reading comprehension scores at the end of the second year fits in with other work which shows that the synthetic phonics approach (although successful at the word-level) does not necessarily led to comparable gains in reading comprehension skills (Bowyer-Crane, et al., 2008). In addition, the reading comprehension of a substantial number of the older children was most likely constrained by poor decoding skills (Gough & Tunmer, 1986). It was unlikely to have been constrained by poor language as demonstrated by the high scores for vocabulary and memory in the later-schooled group at T1 (see chapter 2).

Both groups made steady progress in phonological skills and letter-sound knowledge throughout the first year of reading instruction. The earlier-schooled children began the year with better letter-sound knowledge and maintained this advantage throughout. Conversely, the later-schooled group had significantly better letter name knowledge at the end of the year, leading to similar overall levels of letter knowledge at T3. This difference reflects the different way in which letters are taught in the two systems; the standard synthetic phonics approach emphasises grapheme-phoneme correspondences as represented by letter sounds, while the Steiner approach teaches letter names from Class 1 and only starts introducing letter sounds in Class 2.

The superior phonological deletion skills of the later-schooled group were sustained throughout the year, both in terms of absolute score and in the proportion of children who attained this skill. Given that both analytic and synthetic phonics teach segmentation skills, it is likely that an age effect was operating in this instance to the advantage of the older children. For example, their greater maturity and language skills might have allowed them to more effectively apply what they had learnt to the explicit manipulation of phonemes in the deletion task. Also, their better vocabularies may reflect more detailed phonological representations which are necessary to make phoneme-sized segments available for manipulation (e.g., Walley, 1993). However, the earlier-schooled group made significantly more progress in blending skills between the middle and end of the year resulting in a similar level of performance to the later-schooled children at T3. This pattern of rapid growth is likely to be due to the fact that the synthetic phonics approach (as practised in the standard school) teaches blending skills (synthesis) as an aid to decoding, while the analytic approach favoured by Steiner schools does not (Johnston & Watson, 2004).

3.4.1 *Generalisabilty of the results*

Only three schools took part in the current study making it questionable how far the results can be generalised. All three teachers from the two Steiner schools which took part taught in a fashion that was true to the Waldorf-Steiner philosophy. Also, the two schools covered children from a range of demographic circumstances. The first Steiner school was located in an affluent, semi-rural area while the second Steiner school was in a relatively deprived inner city area (see p.52). Therefore, there is no indication that teaching in these classrooms differed in a great way from that of other Steiner schools in the UK (and other countries where the Steiner method is practised). Finally, the standard school involved was highly representative of other mainstream schools in the UK. Children in the catchment area came from a variety of socio-economic circumstances and the ‘Letters and sounds’ program is being taught or due to be taught at almost all state-run Infant and Primary schools in the UK.

One potential limitation is that the later-schooled children were disadvantaged due to being less familiar with type written text or the types of words used in early reading schemes. The reading and spelling tests (British Ability Scales) were designed for and piloted on standard-educated children within the UK, not Steiner educated children. However, the good vocabularies of the later-schooled group (as demonstrated at T1) suggest that the high frequency words used during the first half of the BAS test would be known to them. Second, materials in both the word reading and letter knowledge tasks were printed in lower case letters. Steiner children start by learning upper case in Class 1 and tend to only move onto lower case in Class 2. Yet, ceiling levels of letter-name knowledge (as tested via lower case stimuli) at the end of Class 2 suggest that by this stage, knowledge of lower case letters was complete. Finally, children in Class 2 were not accustomed to seeing printed (computerised) materials; they were used to reading their teachers' handwriting. However, this became less of a problem in Class 3 with the introduction of published texts.

3.4.2 *Conclusions and further Research*

Our hypothesis that the later-schooled group would make better progress in early literacy was not supported. Both groups made similar progress in reading and the later-schooled group performed worse in spelling. Our findings do not support the assertion that 4-5 years old is too young to begin formal reading instruction and indicate that a delay in school entry age does not necessarily lead to benefits in reading. The majority of 4-5 year-olds in the current study made good progress in early reading and spelling and responded well to the instruction they were given. The children were educated in the most typical manner in a mainstream standard school and were representative of most other children their age (mean vocabulary was close to the national average as was maternal education level). Therefore, concerns that it is not developmentally appropriate to expose 5 year olds to formal reading instruction may be unfounded.

Given previous research, it is unlikely that age-related factors do not influence early reading development. Therefore, it is our interpretation that advantageous age-related processes were counteracted by differences in the quantity and quality of phonics instruction provided to each group. Specifically, less teaching time was spent on teaching phonics in the later-schooled group and the quality of that instruction was less conducive to rapid progress. Therefore, it is likely that age-related factors compensated to a certain extent for these instructional differences in the later-schooled group allowing them to make similar progress in reading. Indeed, had they been exposed to the same method of reading instruction, it is probable that they would have made better progress as predicted. The results highlight method of instruction as a stronger influence, over and above the effect of age-related factors on the development of early literacy.

With regard to controlling for instructional differences, one possibility for future research is to compare the reading development of English-speaking children in Wales with standard-educated children in England. Schools in Wales are currently extending their early years provision for children up until the age of 7½, after which formal reading instruction will commence using a similar method to that employed at English schools (synthetic phonics) ("Framework for Children’s Learning for 3 to 7-year-olds in Wales," 2009). This curriculum change provides an ideal opportunity to measure age effects on early literacy development across a larger age range than is possible using the cut-off method without confounding age with instructional method.

Anecdotal evidence reveals that graduates of Steiner schools are confident and skilled readers who go on to do well at university (Woods, Ashley, & Woods, 2005). This suggests that Steiner pupils must ‘catch up’ with their standard educated peers at a later stage. A brief look at the latest exam results for the first Steiner school (which is the largest Steiner school in the UK) shows that 94% gained an A-C grade for English GCSE (compared to a national average of 62.7%) and 82% of pupils achieved an A-C grade for English A-level (compared to a national average of 78.5%) ("BBC News Exam Results," 2009; Michael Hall GCSE and A level results," 2009). Nevertheless, direct comparisons are difficult due to the fact that Steiner children often take exams a year later than usual and are usually entered for fewer examinations. Also, many children come to Steiner education later, so it would be necessary to only test those children who had attended the Steiner system since infancy. Longitudinal follow-up of the current sample for the next 5-10 years would reveal the long-term effects of the Steiner method for progress in literacy using a controlled comparison with the standard system.

Finally, more research is needed on whether differences in age and instructional method affect which skills a child uses to help them acquire reading. Chapter 4 will investigate which reading-related skills at T1 acted as longitudinal predictors of reading and spelling and whether this differed between groups.

4 The predictors of early literacy in earlier and later schooled children

Abstract

This chapter examines whether the importance of different skills in the prediction of reading changes with age by comparing younger and older beginning readers. Thirty later-schooled children (age 7-9) were compared to thirty-one earlier-schooled controls (age 4-6) on a range of reading-related skills at the onset of formal reading tuition. Phonological awareness predicted substantial variance in reading and spelling one year later for both groups, while letter-sound knowledge was a unique predictor in the later-schooled group only and non-phonological language and memory skills did not contribute significant unique variance in literacy for either group. In conclusion, the skills underlying early literacy development do not seem to change spontaneously with age (they were similar in younger and older beginning readers). However, it may be that instructional emphasis on letter sounds in the earlier-schooled group reduced the power of this variable as a predictor by reducing individual differences in the number of letters known by the end of the year.

4.1 Introduction

There is evidence that the predictors of reading change during the course of development (Muter, et al., 2004; Nation, 2008). However, to date, the majority of research has looked only at children who begin learning how to read from a young age. Therefore, these changes may be the result of increased reading experience rather than ‘natural’ age-related processes such as an improvement in reading related skills. In the current chapter, data from a longitudinal comparison of earlier and later schooled beginning readers (as described in chapters 2 and 3) is used to investigate which reading-related skills at the onset of schooling predict variance in literacy in older and younger beginning readers. The results will help to elucidate the effect (if any) of age and instruction on the skills which underlie early literacy development.

4.1.1 *Predictors of reading*

As outlined in Byrne (1998), learning to decode effectively relies on a sound grasp of the alphabetic principle, that is, understanding that the letters in written words map onto the phonemes in spoken words. Therefore, knowledge of letter sounds and access to phonemic representations of speech are the two essential foundations for learning to read. In accordance with this view, both phoneme awareness and letter knowledge at the onset of literacy instruction have been shown to be highly predictive of early progress in reading and spelling (Caravolas, Hulme, & Snowling, 2001; Hulme, et al., 2002; Muter, Hulme, Snowling, et al., 1997; Muter, et al., 2004). In one study, phoneme awareness and letter knowledge at school entry accounted for 54% of variance in reading at the end of the first year (Muter et al., 2004). If a child wishes to use their awareness of phonemes to manipulate phonological information, then they must have a way of temporarily storing this information in memory. For this reason, short-term verbal memory is also an important predictor of decoding skills (Gathercole, et al., 1992; Muter & Snowling, 1998).

Another skill which has more recently been associated with literacy is visual-verbal paired associate learning (PAL). The suggestion is that this task taps the ability to map orthography with phonology, for example when learning letter sounds and recognising words by sight. Visual-verbal learning, as measured by the ability to pair nonsense names with shapes, has been found to be a unique concurrent predictor of reading (Hulme, et al., 2007; Windfuhr & Snowling, 2001). However, its power as a longitudinal predictor has yet to be investigated.

Broader, non-phonological language skills also play a predictive role in literacy. For example, some studies have shown that vocabulary predicts unique variance in word reading after the effects of phonological awareness and letter knowledge have been controlled (Nation, 2008; Nation & Snowling, 2004; Wagner, et al., 1997). Vocabulary may be operating to aid reading in two ways. First, as a child develops an oral vocabulary, increasingly detailed phonological representations of words are created in order to distinguish between words that sound similar (Metsala & Walley, 1998; Walley, 1993). In turn, phonological representations can be brought into play to decode written words. Second, if the meaning of a word is known, then children can draw upon this semantic information to help in visual word recognition (Nation, 2008; Plaut, McClelland, Seidenberg, & Patterson, 1996).

The predictors of reading comprehension have been found to differ somewhat from those of word-level reading. Reading comprehension is largely an interpretive process and therefore more likely to rely on higher level language skills (Gough & Tunmer, 1986). In accordance with this view, Nation and Snowling (2004) found that vocabulary and other semantic skills (such as semantic fluency and synonym judgement) were more strongly associated with reading comprehension than word recognition. Similarly, other studies have shown that vocabulary predicted independent variance in reading comprehension but not word recognition (Muter, et al., 2004) and reading speed (Caravolas, Volin, & Hulme, 2005).

4.1.2 *Age effects on the predictors of reading*

While the relationship between phonological awareness and reading remains relatively stable between the ages of 5 and 9 (Hogan, Catts, & Little, 2005; Nation & Snowling, 2004; Wagner, et al., 1997), non-phonological language skills such as vocabulary and grammatical awareness may become more important to reading as children develop their reading skills (Nation, 2008; Wagner, et al., 1997). For example, a study by Nation & Snowling (2004) found that vocabulary; semantic skills and listening comprehension were unique longitudinal predictors of word recognition in a group of skilled readers between the ages of 8 and 13. Also, Caravolas, Volin & Hulme, (2005) found that vocabulary contributed unique variance to the concurrent prediction of spelling in groups of Czech and English-speaking skilled readers between the ages of 7 and 12. On the other hand, Muter et al. (2004) showed that vocabulary and grammatical awareness at age 5 made no unique contribution to word recognition at age 7 in a group of English-speaking beginning readers. It may be that as children attain more reading experience and a better sight vocabulary, they rely more heavily on semantic than phonological skills to help them read (Nation, 2008; Stuart & Coltheart, 1988). In accordance with this theory, studies show that children use different strategies between the ages of 5 and 7 to help them read, with a shift from reliance on phonological strategies to directly retrieving words from memory (Ehri, 1995; Farrington-Flint, Coyne, Stiller, & Heath, 2008). By this rationale, a stronger association between vocabulary and word reading would exist in skilled readers, but not in beginning readers.

An alternative explanation for this increased reliance on semantic strategies over time may be the availability of a larger oral vocabulary between early and middle childhood. Typically, there is a vocabulary growth ‘spurt’ which takes place roughly between the ages of 5-7 (Metsala & Walley, 1998). The existence of more detailed semantic representations may lead children to use such information more readily to decipher words. For example, only partial phonological decoding may be necessary in order to recognise a word that is already represented in oral vocabulary (Snow & Juel, 2007). According to this view, vocabulary would predict reading in both beginning and skilled readers, providing they had attained a certain level of skill in this area (usually by the age of 7). Therefore, vocabulary would be a stronger predictor of reading in the later-schooled group (who have high levels of vocabulary) compared to the earlier-schooled group (who have comparatively low levels of vocabulary).

Evidence on the predictors of reading in older beginning readers is available from cross-cultural studies. These studies show us that phoneme awareness and letter knowledge have consistently been found to be important predictors of early reading and spelling across different languages, regardless of starting age or orthographic depth. For example, Levarg, Braten and Hulme, (2009) found that letter knowledge and phoneme awareness accounted for 51% of variability in reading in Norwegian first graders between the ages of 6½ and 7½. Similar results were found in a group of German (Wimmer, et al., 1991) and Finnish (Silven, Poskiparta, Niemi, & Voeten, 2007) first graders of the same age. These levels of variance are comparable to those found in English-speaking children during the first year of school between the ages of 4½ and 5½ (54% in Muter et al., 2004). In all cases, non-phonological language abilities failed to contribute additional variance to the prediction of early literacy. This was the case in both the older beginning readers who spoke other languages and the younger English-speaking beginning readers. The resulting hypothesis is that the older, later-schooled children in the current study will show a similar pattern of predictors to their younger, earlier-schooled counterparts.

Results of cross-cultural studies are, however, limited as they do not control for linguistic differences. All languages in the above studies had regular (transparent) orthographies, meaning that all words can be decoded phonologically. English has an irregular orthography where 20% of words cannot be read with reliance on phonological strategies alone (Snow & Juel, 2007). Therefore, there may be an increased need for semantic skills in English beginning readers compared to those learning to read a regular orthography.

4.1.3 *Instructional effects on the predictors of reading*

Few studies have looked at instructional effects on the predictors of reading. In their longitudinal study, Perfetti et al., (1987) compared the development of phonological and reading abilities in children taught by a direct phonics approach and children taught via a ‘mixed method’ (whole word and phonics). They found that reading ability at the end of the first year of schooling was predicted more strongly by phoneme awareness skills at the beginning of the year for the mixed group than it was for the phonics group. This was despite similar start levels of PA in both groups. The suggestion was that for the direct phonics group, individual differences in PA were reduced due to focused instruction bringing all children to a similar level. Whereas, for the ‘mixed’ group, children were developing PA at a more individual rate so variance in initial PA was more reflective of the progress they made in subsequent reading.

Mann and Wimmer, (2002) compared the phonological skills of a group of German and American children from Kindergarten to second grade. American children are taught reading via a ‘mixed’ method that includes whole word, language and phonic work while German children are taught via a synthetic (direct) phonics approach alone. The relationship between phoneme awareness and reading was significantly weaker in the German than the American group. This may be explained by the greater transparency of the German orthography but also by the increased emphasis on phonics by the teachers. The authors suggested that, similar to Perfetti et al.’s theory, such an emphasis may ‘somehow ease the stress on individual differences in phoneme awareness’ (p. 673). These results would suggest that the relationship between phonological awareness and reading will be weaker in the earlier-schooled group, who were exposed to a more direct method of phonics instruction.

One main question was addressed:

1. Do the predictors of early reading and spelling differ in children educated earlier compared to later in childhood? If so, why?

4.2 Method

These analyses use data from the studies described in chapter 2 (T1) and chapter 3 (T2-4). Data were collected from 30 later-schooled (Steiner educated) children and 31 earlier-schooled (standard educated) children at the beginning (T1) middle (T2) and end (T3) of their first year of formal reading instruction. Additional data from a reduced sample, 19 later-schooled and 19 earlier-schooled children were collected at the end of the second year (T4). Groups were initially pair-wise matched for standardised vocabulary. See chapter 2 for a complete description of the schools, matching procedure and T1 measures. See Chapter 3 for a description of the follow-up measures.

4.3 Results

4.3.1 *Relationships among the tasks*

Correlations among measures at T1-3 (first year) are shown in Table 4.1. Earlier-schooled children are shown above the diagonal and later-schooled children below the diagonal. Because visual-verbal learning (both groups), nonword repetition (earlier-schooled group), phonological awareness at T1 and 2 (earlier-schooled group) and T3 (later-schooled group), letter-sound knowledge (both groups), letter-name knowledge (later-schooled group), and reading at T2 (both groups) were not normally distributed, nonparametric correlations (Spearman's rho) were also calculated. These did not substantially alter the patterns of correlations and so are not reported.

Due to the fact that we wished to assess the predictive value of phonological awareness as a unitary construct, composite scores were calculated by adding the two phonological awareness tasks together (they had the same maximum score).

Correlations between these two measures (deleting and blending sounds) were medium-high at T1 (*r* =.51, .52), T2 (r =.70, .74), and T3 (*r* =.63, .64) in the earlier and later schooled groups respectively. We also wished to look at the predictors of reading in general and had no need to distinguish between exception and non-word reading. Therefore, a composite reading measure was calculated by adding together the raw scores for the word and non-word reading tests. This had the added advantage of removing floor effects evident in the word reading measure. Correlations between the word and non-word reading measures were high at T2 (*r* = .85, .76) and T3 (*r* = .84, .66) in the earlier and later schooled groups respectively.

The correlation matrix reveals both similarities and differences in the pattern of correlations in each group. Moderate-strong correlations were present between the phonological, letter knowledge, reading and spelling tasks in both groups. A noticeable difference was that the language measures at T1 (vocabulary and recalling sentences) correlated well with reading in the earlier-schooled but not later-schooled group while visual-verbal learning was a stronger correlate of literacy in the later-schooled group.

Table 4.1

Correlations between measures T1-3

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Time 1														
1. Vocabulary	-	.30	.21	.64**	.57**	.45*	.54**	.38*	.59**	.56**	.27	.55**	.51**	.33
2. Recalling sentences	.75**	-	.46*	-.11	.33	.41*	.44*	.31	.47**	.50**	.34	.36*	.33	.28
3. Nonword repetition	.45*	.50**	-	-.05	.37*	.29	.23	.24	.32	.29	.14	-.09	.06	.02
4. Visual-verbal learning	.37*	.46*	.33	-	.45*	.09	.30	.12	.35	.30	.17	.46**	.39*	.28
5. Phonological awareness	.13	.21	.28	.27	-	.51**	.74**	.43*	.84**	.70**	.24	.60**	.68**	.58**
6. Letter-sound knowledge	.40*	.48**	.22	.63**	.62**	-	.68**	.72**	.61**	.45*	.22	.59**	.48**	.52**
Time 2														
7. Phonological awareness	.30	.33	.26	.37*	.82**	.66**	-	.53**	.83**	.78**	.39*	.72**	.79**	.65**
8. Letter-sound knowledge	.32	.33	.21	.46*	.56**	.81**	.62**	-	.52**	.45*	.48**	.53**	.58**	.55**
9. Reading	.12	.32	.15	.38*	.78**	.75**	.76**	.61**	-	.77**	.40*	.73**	.77**	.68**
Time 3														
10. Phonological awareness	.25	.33	.25	.43*	.73**	.64**	.91**	.58**	.70**	-	.48**	.66**	.87**	.68**
11. Letter-sound knowledge	.21	.11	.32	.15	.42*	..57**	.45*	.81**	.35	.39*	-	.52**	.55**	.46**
12. Letter-name knowledge	.12	.03	.27	.10	.38*	.47**	.46*	.64**	.38*	.41*	.80**	-	.79**	.78**
13. Reading	.19	.20	.22	.43*	.78**	.81**	.78**	.76**	.82**	.72**	.53**	.49**	-	.84**
14. Spelling	.23	.29	.26	.43*	.69**	.83**	.73**	.81**	.74**	.71**	.57**	.54**	.87**	-

Note. Correlations are Bivariate (Pearson's r). Earlier-schooled group, *n* =31 are shown above the diagonal. Later-schooled group, n = 30 are shown below the diagonal. *$p < 0.05$ (2 tailed), ** $p < 0.01$

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4.3.2 *The predictors of reading at T3*

Hierarchical multiple regressions were performed to examine which reading-related skills at T1 predicted reading at T3 in each group. Phonological awareness is the variable most consistently associated with early reading and spelling ability, therefore, it was entered first in all analyses (Step 1). All other reading-related skills were entered separately in step 2 in order to minimize the number of predictors in each model.

Table 4.2 shows the results of the regressions. Phonological awareness and letter-sound knowledge at T1 were significant predictors of reading at T3 in the later-schooled group while visual-verbal learning approached significance. Phonological awareness was the only significant predictor in the earlier-schooled group. A much higher proportion of variance in reading was predicted by phonological awareness and letter knowledge in the later-schooled ($R^2 = .78$) compared to the earlier-schooled group ($R^2 =.48$). Additional regressions which examined the whole sample and treated group as a dichotomous variable indicated that, together, the two interaction terms (group × phonological awareness and group × letter-sound knowledge) contributed significant variance to the prediction of reading at T3, $\Delta R^2 = .044$, $p <.05$. This means that the combined predictive power of phonological awareness and letter-sound knowledge on subsequent reading was significantly higher in the later-schooled compared to the earlier-schooled group.

Table 4.2

Regressions predicting reading at T3 from T1 variables

	Dependent variable: Reading at T3							
	Later-schooled				Earlier-schooled			
Variable at T1	*B*	*SE B*	*B*	ΔR^2	*B*	*SE B*	*B*	ΔR^2
Step 1				.61**				.46**
Phonological awareness	3.68	0.55	.78**		2.57	0.52	.68**	
Step 2				.17**				.02
Letter-sound knowledge	2.00	0.44	.53**		0.53	0.46	.18	
Step 2				.01				.02
Vocabulary	0.15	0.20	.09		0.31	0.28	.18	
Step 2				<.01				.04
Non-word repetition	-0.03	1.26	<.01		-2.68	1.70	-.23	
Step 2				<.01				.01
Recalling sentences	0.07	0.24	.04		0.33	0.40	.13	
Step 2				.05[a]				.01
Visual-verbal learning	0.66	0.33	.23[a]		0.17	0.25	.11	

Note. ** $p < .01$, * $p < .05$, [a] $p = .06$

4.3.3 *The predictors of spelling at T3*

Table 4.4 shows the results of regressions predicting spelling at T3 from variables at T1. These revealed a similar pattern of results to the reading regressions

(Table 4.3). Phonological awareness and letter-sound knowledge at T1 were significant predictors of spelling at T3 in the later-schooled group while visual-verbal learning approached significance. Phonological awareness was the only significant predictor in the earlier-schooled group. Also, similar to reading, a higher proportion of variance in spelling was predicted by phonological awareness and letter-sound knowledge in the later-schooled (R^2 = .74) compared to the earlier-schooled group (R^2 =.41). Additional regressions which examined the whole sample and treated group as a dichotomous variable indicated that, together, the two interaction terms (group × phonological awareness and group × letter-sound knowledge) did not contribute significant variance to the prediction of reading at T3 (ΔR^2 = .012, p =.46). This means that the combined predictive power of phonological awareness and letter-sound knowledge on subsequent reading was not significantly different between the two groups.

Table 4.3

Regressions predicting spelling at T3 from T1 variables

	Dependent variable: Spelling at T3							
	Later-schooled				Earlier-schooled			
Variable at T1	*B*	*SE B*	*Β*	ΔR^2	*B*	*SE B*	*Β*	ΔR^2
Step 1				.47**				.34**
Phonological awareness	0.61	0.12	.69**		0.66	0.17	.58**	
Step 2				.27**				.07
Letter-sound knowledge	0.48	0.9	.66**		0.26	0.15	.30	
Step 2				.02				<.01
Vocabulary	0.05	0.05	.14		<.01	0.09	<.01	
Step 2				<.01				.04
Non-word repetition	0.13	0.28	.07		-0.80	0.56	-.23	
Step 2				.02				.01
Recalling sentences	0.06	0.05	.15		0.08	0.13	.09	
Step 2				.06†				<.01
Visual-verbal learning	0.14	0.07	.26		0.01	0.08	.02	

Note. ** $p < .01$, * $p < .05$, † $p = .07$

4.3.4 *The predictors of literacy at T4*

Table 4.5 shows correlations between variables at T1-3 and the literacy measures at T4. The table reveals a pattern of correlations similar to those found at T1-3. Phonological awareness and letter-sound knowledge at T1 and T2 correlated medium-strongly with all literacy measures at T4 in both groups, although correlations were slightly higher in the later-schooled group. Vocabulary correlated significantly with all T4 measures in the earlier-schooled group but only displayed weak correlations in the later-schooled group. In addition, visual-verbal learning was a strong correlate of reading at T4 in the later-schooled but not earlier-schooled group. Finally, letter name knowledge correlated strongly with the literacy measures in the earlier-schooled but not later-schooled group. Hotelling's t-tests for significant differences between correlations (one-tailed) revealed that the correlations between letter-name knowledge and word reading, $z = 1.69$, $p<.05$ and spelling, $z = 1.91$, $p<.05$ were significantly higher in the earlier-schooled group.

The correlates of reading comprehension were similar to those of word-level literacy with no large differences between groups. Phonological awareness displayed significant correlations with reading comprehension at all three time points while letter-sound knowledge was only a significant correlate at T1. Vocabulary correlated significantly with reading comprehension in the earlier-schooled group while recalling sentences was a significant correlate in the later-schooled group. Differences in these correlations were not significant.

Table 4.4

Correlation table for measures at T4

Variable	Time 4 measure: Later-schooled				Earlier-schooled			
	Word reading	Spelling	Reading acc.	Reading comp.	Word reading	Spelling	Reading acc.	Reading comp.
Time 1								
Vocabulary	.17	.10	.22	.32	.52*	.48*	.47*	.56*
Recalling sentences	.30	.21	.36	.49*	.55*	.43	.49*	.31
Nonword repetition	.-.01	-.05	-.00	-.05	.13	.06	.19	.42
Visual-verbal learning	.52*	.39	.66**	.39	.25	.33	.28	.33
Phonological awareness	.68**	.45*	.63**	.45*	.51*	.49*	.36	.53*
Letter-sound knowledge	.78**	.62**	.79**	.60**	.51*	.55*	.48*	.57*
Time 2								
Phonological awareness	.66**	.57*	.72**	.53*	.64**	.63**	.45	.51*
Letter-sound knowledge	.56*	.55*	.55*	.35	.42	.49*	.44	.44
Reading	.75**	.63**	.74**	.59**	.61**	.61**	.50*	.50*
Time 3								
Phonological awareness	.63**	.54*	.71**	.50*	.83**	.77**	.72**	.63**
Letter-sound knowledge	.26	.28	.26	.08	.48*	.47*	.42	.10
Letter-name knowledge	.44	.40	.47*	.36	.79**	.80**	.74**	.55*
Reading	.78**	.62**	.74**	.51*	.88**	.90**	.75**	.55*
Spelling	.77**	.67**	.73**	.45	.74**	.82**	.71**	.61**

Note. Correlations are Bivariate (Pearson's r). Later-schooled group, n = 19; earlier-schooled group, n =19. Reading acc. = reading accuracy. Reading comp. = reading comprehension.

*p < 0.05 (2 tailed), ** p < 0.01

4.4 Discussion

This study investigated the effect of age on the predictors of early literacy by comparing groups of older and younger novice readers. In general, the pattern of predictors was similar in both groups; phonological awareness was a strong predictor of literacy at both ages while non-phonological language skills did not contribute significant additional variance at either age. However, there were some notable differences in the strength of these predictors which are discussed below.

Together, letter-sound knowledge and phonological awareness predicted 78% of the variance in reading and 74% variance in spelling in the later-schooled group, compared to 48% in reading and 41% spelling in the earlier-schooled group. This difference was significant for reading. Such a result is in contrast to the findings from cross-cultural studies which showed similar levels of variance between younger English beginning readers and older beginning readers learning transparent orthographies (51-54%) (e.g., Lervag, et al., 2009; Muter, et al., 2004). Learners of regular orthographies tend to experience an intense phonic approach during the first year of school, which is similar to that administered at standard schools in the UK. Therefore, the greater importance of phonological awareness and letter knowledge for the later-schooled children is most likely due to instructional differences rather than age differences between the two groups.

Perfetti et al. (1986) and Mann & Wimmer (2002) found that children who were taught reading via a 'mixed method' (similar to the later-schooled group) showed a closer association between phoneme awareness at the onset of school and reading a year later than children who were taught via a purely phonic approach (similar to the earlier-schooled group). The theory was that instructional emphasis reduced individual differences in PA, thereby reducing the impact of initial variation in PA on subsequent reading. A similar theory can be applied to letter knowledge. In order to test the validity of this theory for the current sample we examined differences in standard deviations for phonological awareness and letter knowledge at T3.

As described in the literature review, the earlier-schooled children, educated at mainstream schools, received more direct, systematic instruction in letter-sounds during the first year of school than their later-schooled counterparts who were educated at Steiner schools. Accordingly, Levene's test showed that there was significantly more variation in letter-sound knowledge at T3 among the later-schooled group than the earlier-schooled group, $F(59) = 16.17$, $p < .01$, despite a similar distribution of scores at T1. On the other hand, comparison of standard deviations for the two phonological measures at T3 indicated that children in the earlier-schooled group did not have less variation in their scores compared to the later-schooled group, $F(59) = 3.87$, $p = .06$ (deleting sounds; the later-schooled children actually had less variation), and $F(59) = 0.22$, $p = .64$ (blending sounds). Therefore, in this instance instructional emphasis does not seem to have led to a reduction in individual differences. An alternative explanation is that phonological awareness at T1 is a poorer predictor in the earlier-schooled group due to the presence of floor effects in the data. Indeed, previous research has found that measures of phoneme awareness taken at age 4 are poor longitudinal predictors of reading for this very reason (Muter & Snowling, 1998).

Interestingly, there was a significantly higher association between word level literacy at T4 and letter-name knowledge at T3 in the earlier-schooled compared to the later-schooled group. Again, the reason may lie in instructional differences. The children in the earlier-schooled sample did not start explicitly learning letter names until year 1 (after T3), whereas, for the later-schooled children in Steiner schools, there was instruction in letter names during Classes 1 and 2 (before T3). In accordance with the above theory, there was significantly more variation in letter-name knowledge at T3 among the earlier-schooled group, $F(59) = 12.44$, $p < .01$.

With regard to non-phonological language skills, vocabulary did not contribute significant additional variance to the prediction of word-level literacy once the effects of phonological awareness had been partialled out in either group. Therefore, our hypothesis that the association between vocabulary and reading would be stronger in the older group due to their higher levels of vocabulary was not supported. Consequently, previous evidence of a stronger association in older children (e.g., Caravolas, et al., 2005; Nation & Snowling, 2004) is most likely due to increased reading experience rather than age-related factors. In fact, correlations between vocabulary and literacy were consistently higher (and mostly significant) in the earlier-schooled group across all four time points while all correlations in this area were non-significant in the later-schooled group. Higher levels of association in the younger children may be due to the stronger relationship between vocabulary and phonological awareness found at T1 (see chapter 2). It may be that the relationship between vocabulary and reading is mediated by phonological awareness for the earlier but not the later-schooled group (Walley, 1993).

The correlates of reading comprehension at T4 were similar to those of word-level literacy (phonological awareness and letter-sound knowledge) with no significant differences between the two groups. Therefore, it is most likely that the dominant predictor of reading comprehension in each group was word reading (as shown by strong correlations with reading at T3 and T4). This is most likely because both groups were in the early stages of reading comprehension where the words that had to be read were within their vocabulary (Storch & Whitehurst, 2002).

4.4.1 *Conclusions and implications*

In conclusion, it would appear that the skills underlying literacy development do not change spontaneously with age; the predictors of early literacy in older and younger children are very similar. However, there is evidence that a strong focus on letter-sound knowledge during the first year of school reduces its power as a predictor of subsequent reading by reducing variation in the number of letter sounds known by the end of the year within a group of children.

In terms of implications, our results suggest that the reading-related skills which should be emphasised by teachers in schools need not be different for children who come to formal education later as opposed to earlier in childhood. Namely, the focus should remain on phonological awareness and letter knowledge. This is similar to practice in other countries where children start learning to read at age 6-7. The current study is particularly pertinent in response to recent changes to the primary curriculum in Wales. The early years stage (age 3-5) and Key stage 1 (5-7) are slowly being replaced by a new play-based foundation phase. Under this new scheme, children will not begin formal reading instruction until age 7 ("Framework for Children’s Learning for 3 to 7-year-olds in Wales," 2009). Our findings suggest that the essentials of the reading curriculum already in place for the younger children need not be changed for the 7 year olds. Although texts may have to change to be more age-appropriate.

5 The relationship between phonological awareness, letter-sound knowledge and reading

Abstract

This chapter examines the relationship between phonological awareness, letter-sound knowledge and reading in earlier and later schooled children. Mediation analyses are used to investigate the direction of a possible causal link between the three variables during the first year of formal schooling. For the earlier-schooled group (age 4-5 years), significant mediation was demonstrated showing that letter-sound knowledge led to phonological awareness which led to reading. On the other hand, in a group of later-schooled children (age7-8 years), no evidence of mediation was found. Interactions between letter-sound knowledge and phonological awareness were non-significant for both groups. Results support the theory that letter-sound knowledge plays a causal role in the development of phoneme awareness. It is suggested that this connection is, in part, due to the nature of synthetic phonics instruction delivered in standard schools.

5.1 Introduction

In accordance with theories of the foundations of reading acquisition described earlier in this thesis, phonological awareness and letter-sound knowledge at the onset of instruction predicted substantial variance in reading at the end of the year for children educated earlier and later in childhood (see chapter 4). However, the relationship between phonological awareness and letter knowledge is complex and it can be hard to separate the influence of each due to their shared variance (see Bowey, 2007; Kim, 2009). Hulme, Snowling, Caravolas and Carroll (2005) suggested that it would be useful to test for moderator and mediator effects between phoneme awareness and letter-sound knowledge as this would help to elucidate their respective influences on reading. A mediator is a factor that causes (either wholly or in part) the relationship between two variables (Baron & Kenny, 1986), while a moderator is a variable that moderates the strength of the relation between a predictor and an outcome (Aiken & West, 1991). In the current chapter, we test for such effects in the earlier and later schooled groups described in previous chapters, and relate the findings to theories about the relationship between letter knowledge, phoneme awareness and reading.

5.1.1 *Group differences in the relationship between letter-sound knowledge, phonological awareness and reading*

In chapter 4, we found that letter-sound knowledge at T1 contributed unique variance to the prediction of reading at T3 in the later-schooled group (after the effect of phonological awareness at T1 had been controlled), but not the earlier-schooled group. However, this does not necessarily mean that letter knowledge at T1 made no contribution to reading at T3 in the earlier-schooled group. Bowey, (2007) claimed that it was not sufficient to use hierarchical regression techniques to separate the predictive power of letter knowledge and phonological awareness, as it precluded the possibility of mediation. Specifically, it could be that letter-sound knowledge in this group influenced reading indirectly, via phonological awareness. This possibility is investigated in the current chapter through the use of mediation analyses.

Over the course of the year, the earlier-schooled children were exposed to systematic tuition in synthetic phonics. Such tuition involves instruction in certain letter sounds before being taught how to segment and blend words at the level of the phoneme. This pattern of instruction is evident in the data which shows high levels of letter-sound knowledge and low levels of phonological awareness in this group at T1 (see chapter 2). Therefore, for these children, letter-sound knowledge is more likely to lead to phonological awareness than vice versa. On the other hand, the later-schooled group were exposed to an entirely different method of instruction at the Steiner schools. Under the Steiner system, letter sounds are not directly linked to phonological manipulation in the same way (see literature review), and children develop a significant level of phonological awareness before the onset of reading instruction (see chapter 2). Therefore, letter-sound knowledge is less likely to lead to phonological awareness in this group. Again, this possibility is examined by testing for a mediator effect in this group.

5.1.2 *Theories on the relationship between letter-sound knowledge, phoneme awareness and reading*

There are three principal views on the relationship between letter knowledge and phoneme awareness. First, there is the view that each variable represents a separate skill, each of which has a direct relationship with reading. The basis for this is the ‘alphabetic principle' which posits that being able to read relies on understanding that the letters in written words map onto phonemes in spoken words (Byrne, 1998).

Second, is the opinion that phoneme awareness is caused, either wholly or in part, by letter-knowledge. The strictest interpretation being that the ability to manipulate individual phonemes develops as a consequence of specific letter-sound (orthographic) knowledge (Castles & Coltheart, 2004). However, Hulme, Caravolas, Malkova and Brigstoke, (2005) found that many children could isolate phonemes for which they did not know the corresponding letter, showing that the relationship was not as specific as Castles and Coltheart suggest. More likely is the possibility that knowledge of a certain number of letters stimulates awareness of phonemes more generally. In support of this theory, Carroll (2004) found that pre-schoolers must know at least 4 letters before they can succeed on explicit phoneme awareness tasks and Bowey, (1994) showed that 5-year-old non-readers needed to know a minimum of 6 letters before they displayed sensitivity to phonemic units. Further evidence that letter knowledge causes phoneme awareness comes from studies which show that letter knowledge at T1 predicts phoneme awareness at T2, but not vice versa (Johnston, Anderson, & Holligan, 1996; Wagner, et al., 1994). This kind of relationship is an example of mediation; namely that phoneme awareness mediates the link between letter-sound knowledge and reading.

Third, there is the view that phoneme awareness and letter-sound knowledge interact to influence subsequent reading. Consistent with this viewpoint is evidence in support of 'phonological linkage'; that training in phonological awareness is more effective at improving reading skills when accompanied by instruction in letter sounds (Bradley & Bryant, 1983; Bus & van IJzendoorn, 1999; Hatcher, et al., 1994). Such a relationship is an example of moderation. Moderation was demonstrated by Muter, Hulme & Snowling, (1997) who found that, in addition to variance predicted by each variable separately, the interaction term ‘letter knowledge at T1 multiplied by phoneme segmentation at T1’ predicted reading and spelling at T2. This means that the more letters a child knew, the stronger the relationship between their ability to segment phonemes and their subsequent progress in reading and spelling. Similarly, the better their phoneme awareness, the stronger the relationship between the number of letters they knew and their subsequent literacy ability.

Finally, there is a logically plausible fourth view; that phoneme awareness causes letter knowledge. This is unlikely given the fact that specific orthographic knowledge is needed to learn letters, and therefore must be taught. However, partial mediation is possible as phoneme awareness may stimulate the acquisition of letters by allowing children to be more sensitive to the individual sounds in words.

5.1.3 *The current study*

Mediation analyses were conducted using data from the first longitudinal study presented in this thesis (collected during the first year of formal reading instruction). As we had data from three time points, we were able to effectively test which chain of causality (if any) was operating between letter-sound knowledge, phonological awareness and reading in the earlier and later-schooled groups separately. Two sets of mediation analyses were conducted; one where letter-sound knowledge was placed first in the causal chain, and one where phonological awareness was placed first. Moderation analyses were also carried out to test for interactions.

Two main questions were addressed:

1. Does phonological awareness mediate the relationship between letter-sound knowledge and reading, or vice versa?
2. Is the order and/or strength of this relationship different in children educated earlier compared to later in childhood?

5.2 Method

These analyses use data from the studies described in chapter 2 (T1) and chapter 3 (T2-3). Data were collected from 30 Steiner-educated (later-schooled) children and 31 standard-educated (earlier-schooled) children at the beginning (T1) middle (T2) and end (T3) of their first year of formal reading instruction. Groups were initially pair-wise matched for standardised vocabulary. See chapter 2 for a complete description of the schools, matching procedure and T1 measures and chapter 3 for a description of the longitudinal measures. For the current chapter, data were used from tests of letter-sound knowledge, phonological awareness (composite of deleting and blending sounds) and reading (composite of word and non-word reading). The first 3 questions in each phonological task measured syllable awareness while the next 17 measured phoneme awareness. Unfortunately, it was not possible to use data from the phoneme awareness items exclusively, as 21/61 children scored 0 on these items at T1.

5.3 Results

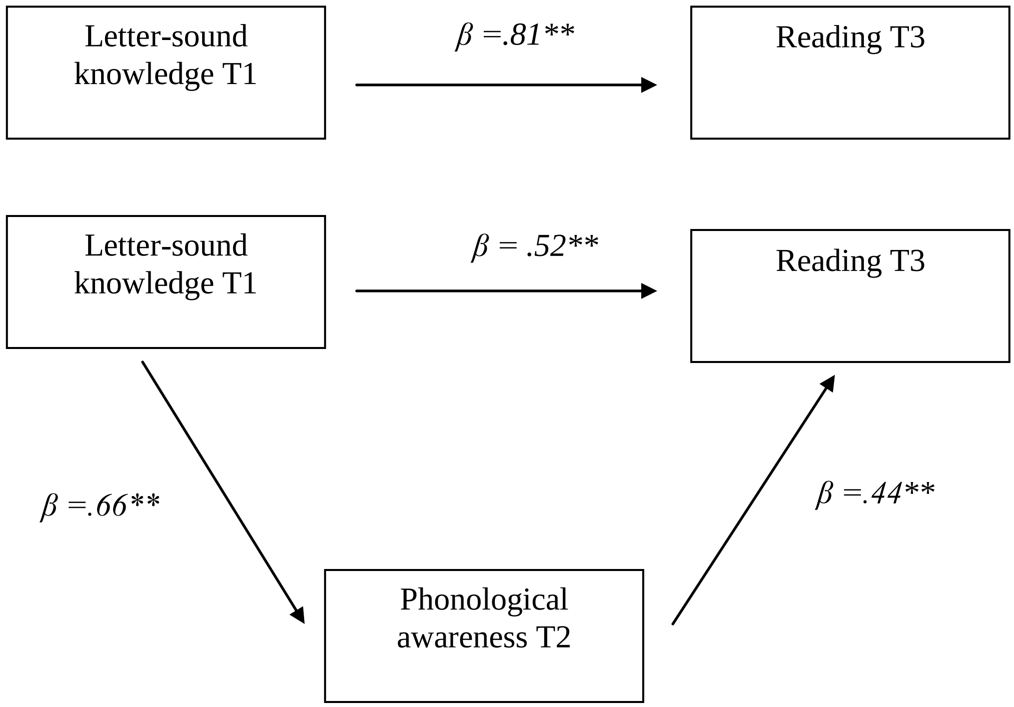
Table 4.1 (p.120) shows correlations between measures at T1-3. In both groups, there were significant correlations between the predictors (letter-sound knowledge and phonological awareness at T1) and the outcome (reading at T3), rs ranged from .48-.81. There were also significant correlations between the mediators (letter-sound knowledge and phonological awareness at T2) and the outcome, rs ranged from .58-.79 in the two groups.

5.3.1 *Letter-sound knowledge leads to phonological awareness*

First, multiple regressions were conducted to test whether the relationship between letter-sound knowledge and reading was mediated by phonological awareness (presented as a path diagrams in figures 5.1 and 5.2). Mediation was tested using Baron and Kenny's (1986) three steps followed by Sobel's test (Sobel, 1982).

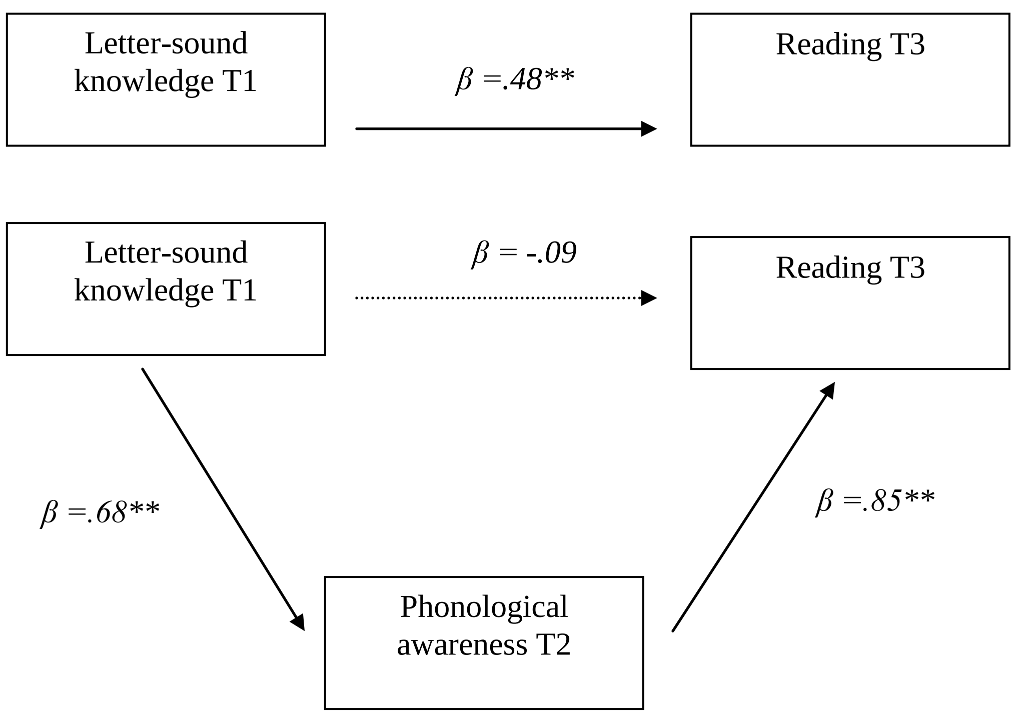
Baron and Kenny's (1986) first step requires the predictor to be related to the mediator. Letter sound knowledge significantly predicted phonological awareness in the earlier-schooled and later-schooled groups, therefore fulfilling the first step. The second step requires the predictor to be related to the outcome, and was fulfilled for both groups. In the third step, the mediator must be related to the outcome, after controlling for the predictor. Again, this step was met in both cases. Mediation is demonstrated if controlling for the mediator significantly reduces the relationship between the predictor and the outcome (compared to the zero-order correlation). Sobel's z tests whether the decrease in β is statistically significant, and is therefore equivalent to testing the significance of the mediated pathway. As shown in figures 5.1 and 5.2, Sobel's test (one-tailed) was non-significant in the later-schooled group (p= .36) and significant in the earlier-schooled group (p <.05). Therefore, mediation was demonstrated in the earlier-schooled group only.

Figure 5.1. Letter-sound knowledge and reading in the later-schooled group



z = 0.92

Figure 5.2. Letter-sound knowledge and reading in the earlier-schooled group



z = 1.69*

5.3.2 *Phonological awareness leads to letter-sound knowledge*

Next, a similar set of multiple regressions were conducted to test whether the relationship between phonological awareness and reading was mediated by letter-sound knowledge (presented as a path diagrams in figures 5.3 and 5.4). As demonstrated in the path diagrams, Baron and Kenny's first three steps were met for both the earlier and later-schooled groups. Sobel's tests (one-tailed) showed that controlling for letter-sound knowledge did not significantly reduce the relationship between phonological awareness and reading in either the later-schooled (*p* =.16) or earlier-schooled (*p* = .29) group. Therefore, mediation was not demonstrated for either group.

Figure 5.3. Phonological awareness and reading in the later-schooled group

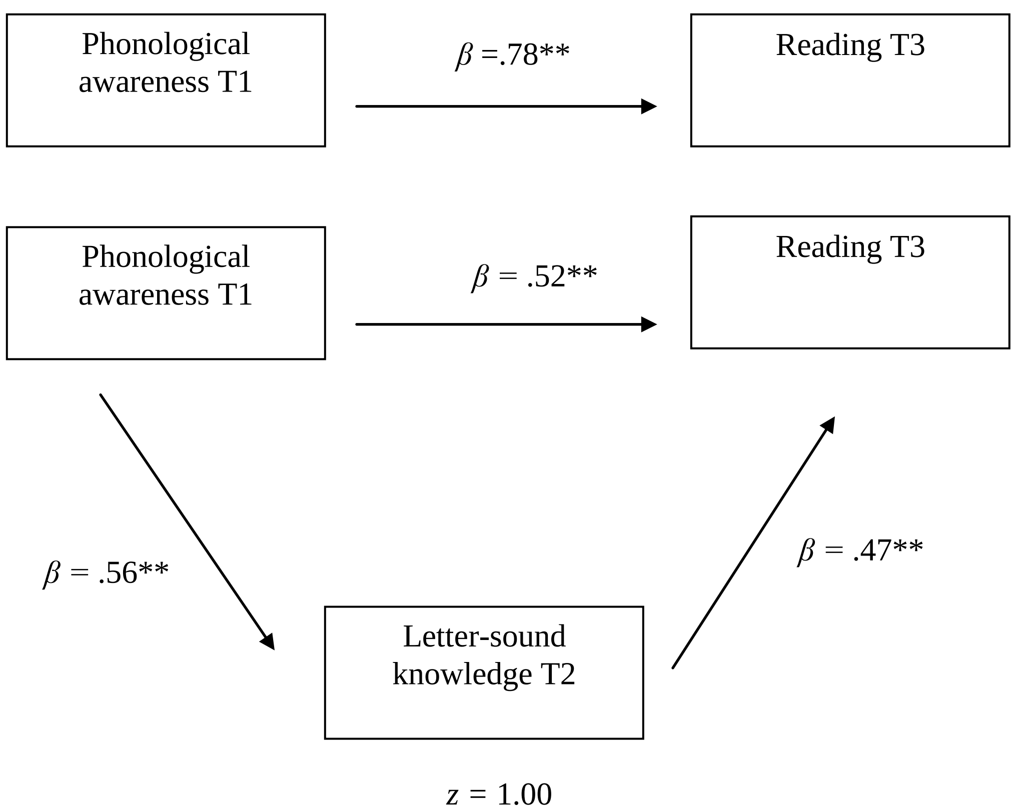
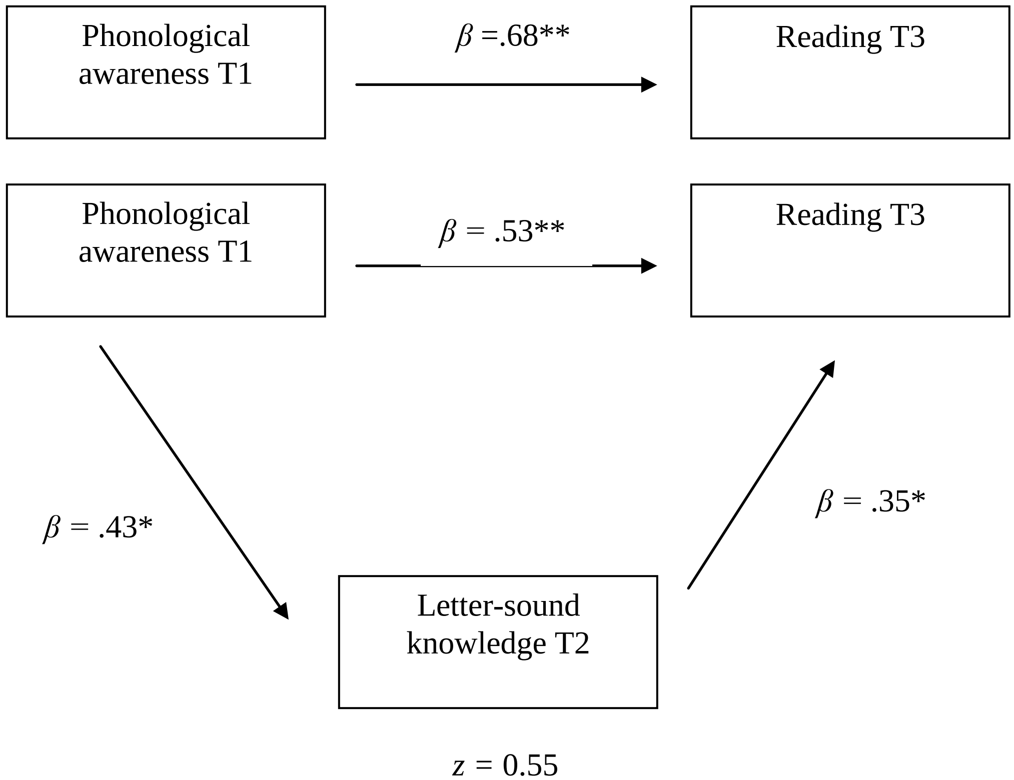


Figure 5.4. Phonological awareness and reading in the earlier-schooled group



5.3.3 *Moderation analyses*

Moderator effects were explored by calculating the interaction term, letter-sound knowledge at T1 × phonological awareness at T1 (see figures 5.5 and 5.6). Hierarchical multiple regressions were performed to determine whether the interaction was significant according to the steps laid out in Aiken and West, (1991). Letter-sound knowledge and phonological awareness were entered in step 1 and the interaction term in step 2. Interestingly, none of the three variables contributed unique variance to the prediction of reading in the later-schooled group; this is probably due to their high degree of shared variance. The interaction terms did not contribute significant variance to the prediction of reading in either the later-schooled, $\Delta R^2 = .01$, $p = .25$, or earlier-schooled group $\Delta R^2 = .06$, $p=.07$. This means that children with good letter-sound knowledge at T1 did not have a significantly stronger link between their phonological skills at T1 and reading than children with poor letter-sound knowledge (and vice versa).

Figure 5.5. A moderation model for the later-schooled group

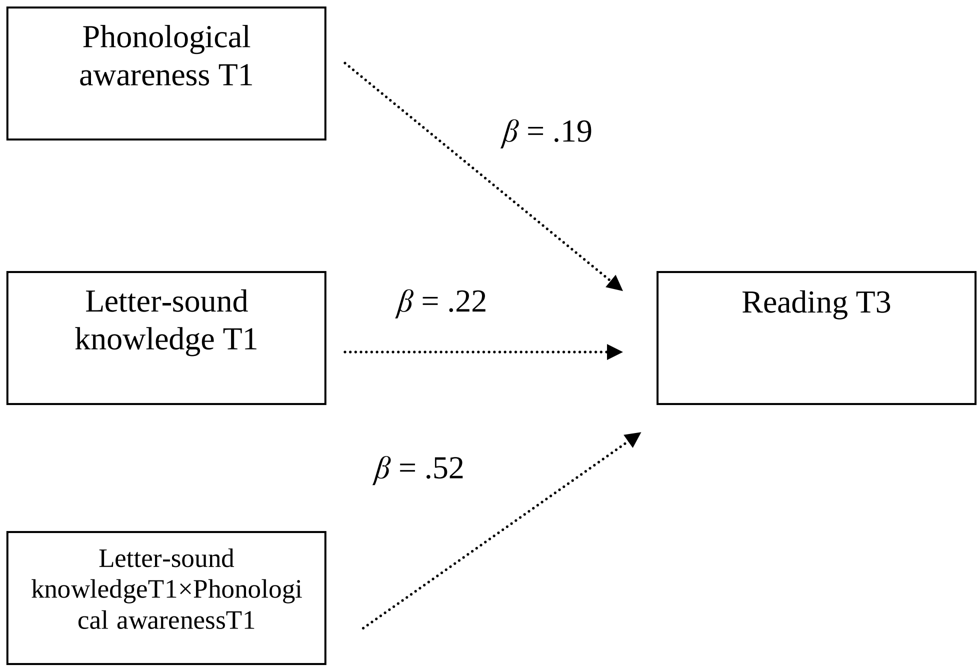
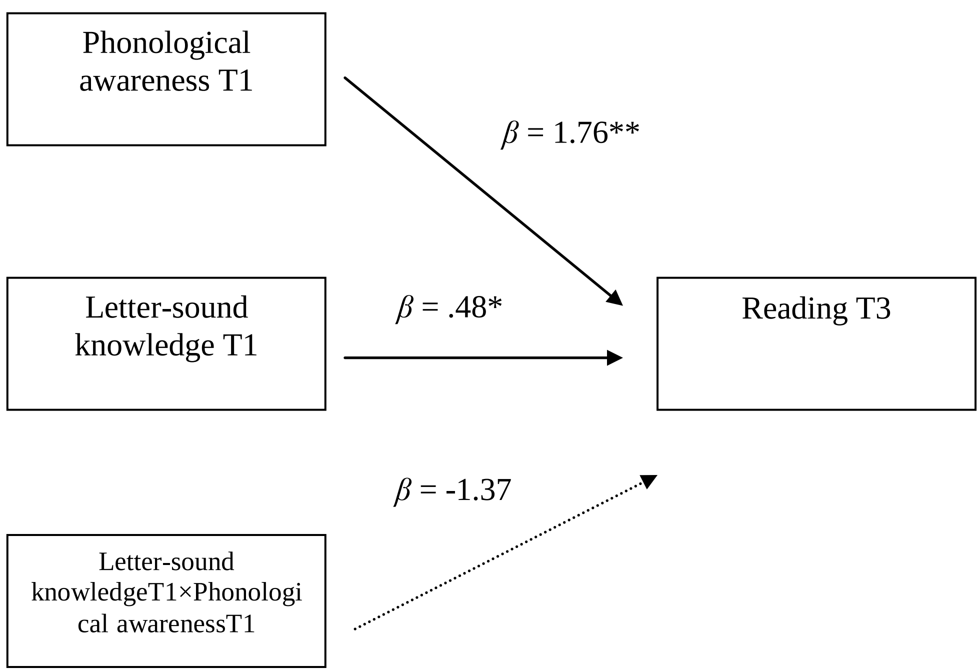


Figure 5.6. A moderation model for the earlier-schooled group



5.4 Discussion

This study investigated the nature of the relationship between letter-sound knowledge, phonological awareness and reading in children educated earlier compared to later in childhood. Significant mediation was demonstrated in the earlier-schooled group, showing that letter-sound knowledge led to phonological awareness which in turn led to reading. In the later-schooled group, there was no evidence of mediation, regardless of whether letter-sound knowledge or phonological awareness was placed first in the causal chain. Interaction terms for both groups were non-significant.

Findings with regard to the earlier-schooled children are in line with our hypothesis that letter-sound knowledge would lead to phonological awareness in this group. More generally, the discovery of mediation in this direction is consistent with the second viewpoint outlined in the introduction. Such a relationship can, in part, be attributed to the kind of teaching the earlier-schooled children received as part of the 'letters and sounds' program ("Letters and Sounds: Principles and practice of high quality phonics," 2007). This program prescribes that children learn letter sounds first before they are taught to segment and blend words at the level of the phoneme, thus encouraging a link from letter sounds to phonological skills. Mediation demonstrates that (contrary to what is suggested by the results of hierarchical regressions presented in chapter 4), letter-sound knowledge at T1 does contribute variance to the prediction of reading at T3 in the earlier-schooled group, albeit indirectly, via phonological awareness. It is also noteworthy that the interaction term 'phonological awareness T1 × letter-sound knowledge T1' approached significance (p = .07), indicating that moderation may have been occurring in this group as well as mediation. Again, this is consistent with the close way in which letters and phonology are linked together during synthetic phonics teaching.

In the case of the later-schooled group, mediation was not demonstrated. These children developed a good degree of phonological skills prior to the onset of formal reading instruction, suggesting that they ‘picked-up’ phonological skills from related activities (e.g., rhyming games and music – see chapter 2). The absence of a ‘causal chain’ in this instance may be due to the fact that children were developing phonological skills from activities unrelated to letter learning. When letter learning was introduced at the Steiner schools, it was conducted in a highly visual manner with a focus on letters in the initial position only (see literature review). Therefore, letter sounds were not linked to phonological skills in the same way as in standard schools. In this group, letter knowledge exerted a direct influence on reading independent of phonological awareness.

5.4.1 *Conclusions and further research*

In conclusion, our findings support the view that phoneme awareness is partially caused by letter-sound knowledge. It is also suggested that this relationship is, in part, caused by the method of synthetic phonics instruction received by standard-educated children during the first year of schooling. This could have implications for classroom practice. For example, if letter knowledge leads to phonological awareness, then children who enter mainstream schools with poor levels of letter knowledge would benefit from learning more letters before instruction in segmentation and blending begins. Also, lack of mediation in the later-schooled group suggests that children do not automatically link letter sounds with phonological skills. Therefore, tuition which helps them to make these links is likely to be useful.

The current study suffers from a few limitations, all of which could be addressed through further research. First, a measure of phoneme awareness alone would have been more appropriate than the current measure of phonological awareness (a composite of syllable and phoneme deletion and blending skills). As outlined in the introduction, previous research has led to stronger theories about the direction of causality between letter knowledge and phoneme awareness than between letter knowledge and phonological awareness in general. Unfortunately, it was not possible to use data from only the items which tested phoneme awareness due to the presence of significant floor effects in the earlier-schooled group at T1. However, the majority of correctly answered items at T2 measured awareness at the level of the phoneme, giving us confidence that findings from the first mediation analyses (letter-sound knowledge at T1 leads to phonological awareness at T2) can be generalised to phoneme, as well as syllable awareness.

Second, mediation alone is not complete evidence of a causal link, just evidence of the organisation of the causal chain (Baron & Kenny, 1986). In order to establish causality, additional evidence is needed. For example, intervention studies showing that training in letter-sound knowledge leads to improvements in phonological awareness, as well as evidence that any beneficial effects were specific to reading e.g., by also testing mathematics, would be necessary (Castles & Coltheart, 2004; Hulme, Snowling, et al., 2005). Unequivocal evidence of a causal link would also require testing of a group of children with no phoneme awareness skills at T1 to show that PA had not aided performance on the letter knowledge task (Castles & Coltheart, 2004).

6 Phonological learning as a function of age and exposure to reading instruction

Abstract

This study tests the validity of a dynamic measure of phoneme awareness and investigates age and schooling effects on the development of early literacy and phoneme awareness skills. The dynamic measure was a better predictor of reading and spelling six months later than a static measure, and was not subject to the same floor effects. Age effects were determined by comparing the oldest children in Year 1 to the youngest children in Year 1, while schooling effects were determined through comparison with the oldest children in Reception (‘cut-off’ method). There were significant age effects on measures of phoneme awareness, word reading, spelling and letter-name knowledge, and significant schooling effects on all tasks. It is suggested that the better reading and spelling of the older Year 1 children was due to an improved ability to learn phonological skills between the ages of 5 and 6.

6.1 Introduction

It is notoriously difficult to measure phoneme awareness in children with little or no reading ability. Tasks which require a choice between possible responses like detection and oddity are generally easier than tasks which require production like deletion (Hulme, et al., 2002). However, explicit PA tasks like deletion and segmentation are generally considered more valid than forced choice tasks because they require a higher level of awareness to solve, and because they avoid chance effects. Often, floor effects (Muter, Hulme, Snowling, et al., 1997; Muter, et al., 2004) or below chance levels (Bowey, 1994; Carroll, 2004) are evident on these tasks in young children who have been in formal schooling for less than a year. Sometimes, PA is not measured in pre-school children because it is assumed that they will be at floor (e.g., Carroll, et al., 2003). Furthermore, as a result of these floor effects, PA measured at the onset of schooling is not as strong a predictor of reading and spelling as the same measures taken during the second and third year of school (Muter & Snowling, 1998). Similarly, in the current thesis, we found that PA was less predictive of subsequent reading and spelling in young children with lower mean levels of PA compared to older children with higher mean levels (see chapter 4, this thesis), despite both groups being beginning readers. These issues emphasise the importance of developing a suitably sensitive measure of explicit phoneme awareness that is appropriate for young children. In the current study, we have used dynamic assessment techniques to develop such a measure.

6.1.1 *Dynamic assessment techniques*

According to Vygosky's (1978) theory of the zone of proximal development, children are capable of achieving levels of performance beyond their actual developmental level, if provided with appropriate guidance. Most tests are 'static' in that they assess only two states: unaided success and failure. However, from a Vygotskian perspective, a child may be somewhere in between these two states: unable to perform the task independently but able to achieve success with assistance. During a dynamic test, if the child initially provides an incorrect answer, the experimenter gives assistance in order to guide the child to the correct response. This can be done by modifying the format, providing additional examples or trials, modelling an appropriate strategy for success, or offering increasingly more explicit cues or prompts (Campione, 1989). The level of assistance required is used as an indication of learning potential as well as current attainment.

An advantage of dynamic assessments is that, by reducing ancillary task demands, they may be a 'cleaner' measure of the target ability. Poor performance from a young child on a phoneme awareness task might indicate poor phoneme awareness. However, it might also reflect a child's lack of understanding of instructions or difficulty in meeting ancillary task demands (Spector, 1992). For example, during a phoneme deletion task, a child might be asked to 'say snail without saying /n/'. If they fail to do so, it might be due to poor phoneme awareness, but might reflect difficulty in understanding what 'saying the word without' means. It might also reflect difficulty in retaining the instructions and the word in short-term verbal memory and even a lack of confidence/ fear of an incorrect response. Dynamic measures are effective at avoiding these pitfalls.

Another advantage of dynamic measures is that because they are tapping learning potential, they are more predictive of how a child will perform in the future (Grigorenko

& Sternberg, 1998). For example, two children may achieve a score of zero on a question in a static phoneme deletion task. However, in a dynamic measure, the first child may produce the correct answer to the same question after one prompt (minimal assistance), while the second child may require 5 prompts to achieve the correct response (high level of assistance). It is reasonable to assume that the first child will achieve more growth in phoneme awareness over time and will probably turn out to be a better reader than the second child, even though in the static measure, they both achieved the same score.

In accordance with this theory, Spector (1992) found that a dynamic test of PA was more predictive of subsequent reading in a group of Kindergartners than a static measure. In a similar vein, Byrne et al., (2000) found that progress during phoneme identity training (number of teaching sessions required to successfully identify a phoneme), predicted gains in reading one, three and six years later over and above that accounted for by level of phoneme awareness achieved post intervention. Similar results were achieved by Hindson et al., (2005) on a group of children at risk of reading disability. In these cases, the ‘progress’ score used mirrors closely the number of prompts provided on a dynamic assessment (Grigorenko, 2009).

6.1.2 *Age and schooling effects on phoneme awareness and early literacy skills*

As discussed in the literature review, alphabetic literacy has been identified as the principal cause of growth in phoneme awareness (Castles & Coltheart, 2004), with evidence of only minimal levels of this skill in pre-readers (Geudens & Sandra, 2003; Hulme, Caravolas, et al., 2005). Consistent with this view, research using the cut-off method shows a strong effect of schooling and no significant effect of age on phoneme segmentation skills during the first year of formal reading instruction (Bowey & Francis, 1991; Christian, et al., 2000; Morrison, et al., 1995). However, there is evidence that phoneme awareness may be enhanced by age-related processes during the year preceding formal reading instruction (Bentin, et al., 1991; Morrison, et al., 1995). This could be due to greater exposure to activities which enhance phonological skills in older children such as rhyming games, music and poetry (e.g., Fazio, 1997a; Fazio, 1997b). However, once reading instruction begins, its effect is so powerful as to supersede the age effect, which means that the age effect does not persist in first grade (Morrison, et al., 1995).

With regard to early literacy skills, there is evidence of age and schooling effects on measures of reading and letter knowledge during the first years of school, with the effect of schooling being consistently stronger than the effect of age. Using the cut-off design, Crone & Whitehurst (1999) found that a year in second grade was equivalent to 4.3 times the effect of 12 months difference in age on a test of word reading. Similar results were found by Morrison et al., (1997) on tests of word reading and letter-knowledge.

6.1.3 *The current study*

In chapter 2, there was a significant effect of both three years of schooling and three years extra age on two measures of explicit phonological awareness. However, the groups came from somewhat different educational and socio-economic backgrounds, factors which may have led to an exaggeration of the age effect. In addition, the two phonological tasks used were subject to floor effects for the 4-5 year old group and led to only a dichotomous measure of phoneme awareness skills. In the current chapter, we look more closely at age and schooling effects on the development of phoneme awareness and early literacy skills by using more sensitive measures of PA in children carefully matched on background variables. Using the ‘cut-off’ method, three groups of children aged 4-6, differing by one year of schooling or by almost a year in age were compared on dynamic and static measures of phoneme awareness. The power of these measures to predict reading and spelling was assessed at follow-up six months later.

The present study bears similarities to a previous investigation by Bowey & Francis (1991). In this case, the youngest and oldest children in first grade were compared to the oldest children in Kindergarten on tests of onset/rime and phoneme awareness. It was found that the first graders outperformed the Kindergartners on all tasks (schooling effect), but that there was no evidence of an age effect as both first grade groups performed at equivalent levels. However, the study raised some issues of methodology. First, oddity tasks were used which could be solved on the basis of global similarity between words and were therefore not necessarily reflective of explicit phoneme awareness (Carroll & Snowling, 2001). Oddity tasks have also been shown to have very low reliabilities compared to deletion and detection tasks (Hulme, et al., 2002). Second, none of the Kindergarten children scored above chance on the task requiring phonemic analysis, leading to the conclusion that PA cannot develop in the absence of reading. However, it may be that the measure was no sufficiently sensitive to detect the presence of PA in this group. Finally, the study was cross-sectional meaning that the value of the tasks as a longitudinal predictor of reading could not be assessed, thus raising questions about their validity. The current study improves upon that of

Bowey & Francis (1991) through the use of more sensitive and reliable measures of explicit phoneme awareness and longitudinal follow-up.

Three main questions are addressed:

1. Are dynamic assessment techniques more appropriate than static techniques for measuring PA in young children?
2. What are the effects of age and schooling on the development of phoneme awareness during the first two years of formal schooling?
3. What are the effects of age and schooling on the development of early literacy skills during the first two years of formal schooling?

6.2 Method

6.2.1 *Participants*

Participants were 45 children, recruited from one Infant school in a semi-rural area of Warwickshire. The school was classified by ACORN as being in a 1,A,1 area: Category; wealthy achievers, Group; wealthy executives, Type; affluent mature professionals, large families. Children were selected on the basis of being born within 3 months of the 'cut-off' date (31st August). Fifteen of the oldest children in the Reception year (OR) were compared to 15 of the youngest children in Year 1 (Y1), who in turn were compared to 15 of the oldest children in Year 1 (O1). Each group represented 20% of children in the year group. The OR group consisted of 7 girls and 8 boys, the Y1 group of 9 girls and 6 boys, and the O1 group of 5 girls and 10 boys.

All groups completed the BPVS vocabulary test at the start of the Reception year. Data for the two year 1 groups was collected one year prior during screening for the first longitudinal study in this thesis (see chapter 2). There were 15 older children in

Reception born within 3 months of the ‘cut-off’ date; therefore, all were included in the final sample. In year 1, there were 22 older children and 17 younger children, allowing for some degree of selection to take place. Therefore, 15 of the older children were pairwise-matched to 15 of the younger children on the basis of standardised vocabulary score (within 4 points).

There was an average of 9 months difference in age between the O1 and the Y1 groups and an average of 2 months difference in age between the OR and Y1 groups. At T1 the average age in the OR group was 5;0 years, range 4;11 -5;2. In the Y1 group it was 5;2 years, range 5;1 -5;4, and in the O1 group it was 5;11 years, range 5;10- 6;0. Data for five tasks was not collected from one child in the OR group due to refusal to participate. See Table 5.1 for a list of background characteristics.

6.2.2 *Design and procedure*

The full sample was tested at two times points during the course of one school year, once during October-November (Time 1) and again six months later during April/May (Time 2). Children were tested in a quiet corner of the school over a period of 3-4 weeks. At T1, the year 1 children were tested for two sessions lasting 15-20 minutes each and the Reception children during 3 sessions (due to the addition of the vocabulary task), lasting about 15 minutes each. At T2, the Year 1 children were tested for one session lasting 15-20 minutes and the Reception group for two sessions lasting about 15 minutes. Sessions were shorter for the Reception children to encourage concentration. Tasks were presented in fixed order with the literacy and phonological tests interspersed to maintain interest. Tasks undertaken at each time point are listed below.

Time 1. Word reading, letter-sound knowledge, letter-name knowledge, phoneme deletion (beginning and end sounds), dynamic phoneme segmentation, vocabulary.

Time 2. Word reading, spelling, letter-sound knowledge, letter-name knowledge, static phoneme segmentation 1 and 2.

6.2.3 *Materials*

Literacy tasks

Letter-sound knowledge. Each of the 26 lower case letters were presented individually on cards in random order. Children were asked to pronounce the sound of the letter. If they replied with the letter name, they were asked if they knew what the letter sound was.

Letter-name knowledge. Same as above except that children were asked to pronounce the name of the letter, not the sound. If they replied with the letter sound, they were asked if they knew what the letter name was. The sample-specific reliability for this task was high, Cronbach's $\alpha = .94$.

Word reading. Test was from the British Ability Scales 2 (BAS) (Elliot, et al., 1996). Children were asked to read as many words as possible from a list. The test was discontinued after 8+ incorrect answers in a block of ten. The published split-half reliability of this test was high at .88 (five year olds).

Spelling. Spelling was measured using the British Ability Scales 2 spelling test. Children were asked to spell individual words in pencil on a numbered answer sheet. The words were presented orally by the experimenter within a sentence and repeated if necessary. Encouragement was given to guess the spelling of unfamiliar words. All children began with item 1 but moved to the next block if they spelt the first two words correctly. The test was discontinued if they got 8+ wrong in a block of 10. The published split-half reliability of this test was high at .84 (five year olds).

Phoneme awareness tasks

Development of the dynamic PA task. It was our original intention to use the task designed by Spector, (1992), but pilot work showed that it was inappropriate for use on children with basic literacy skills, who often used orthographic information to solve the tasks. Therefore, we decided to adapt the task. Each word from Spector's original task was substituted with a more complex non-word, which children in Year 1 would be unlikely to be able to spell with complete accuracy. Non-words were selected to provide a range of vowel and consonant sounds, including consonant clusters and to vary in length from 2 to 6 phonemes. Also, an instruction was added that children were to tell us the sounds they *hear* in the word, not how to spell it, and an example given of where these differed. Piloting of this task on eight children within the target age range revealed that the problem of children trying to spell-out words was virtually eliminated resulting in a more accurate test of phoneme awareness.

Dynamic phoneme segmentation. Children were asked to segment 12 non-words into their constituent phonemes. Children were asked, for example, 'what are the sounds in *shreb*?*'* and were given increasingly explicit prompts to help them solve the task e.g., 'what's the first sound you hear in *shreb*?' to modelling segmentation of the word with counters '*sh-r-e-b'*. There were 7 prompts in total and scores ranged from 6 (no prompts required) to 0 (failed to segment after 7 prompts) per item. Prompts 5, 6 and 7 (which required imitation only) were all given a score of 1 due to the fact that, according to Spector, 1992, measurement on a 8 point scale produced equivalent scores to measurement on a 6 point scale (see Appendix 3 for a description of the prompts and list of items). The sample-specific reliability for this task was high, Cronbach's α = .94

Static phoneme segmentation. A static phoneme segmentation score was derived from the dynamic assessment by giving a score of 1 if no prompts were required and a score of 0 if any prompts were required (as would be the case had it been administered as a static task). At T2, the same items from the dynamic task were administered again as a static task; no prompts were given. The sample-specific reliability for this task was good, Cronbach's α = .81.

In addition, a second task in which children were asked to segment non-words with the same length and vowel/ consonant combinations as in the first task was administered at T2. This was to avoid the possibility that children may have remembered answers to the first set of items when they had been administered dynamically (see Appendix 3 for a list of items). The sample-specific reliability for this task was medium, Cronbach's α = .68.

Phoneme deletion. The Phoneme Deletion (beginning and end sounds) sub-test from the Phonological Abilities Test (PAT) (Muter, Hulme, & Snowling, 1997) was administered as a static measure of phoneme awareness. In the first part, children were asked to remove the initial phoneme of single syllable words and in the second part they were asked to remove the final phoneme of single syllable words e.g., 'In each one you have to take off the first sound of the word and say what's left over'. There were 4 demonstration items, followed by 8 test items in each part, all accompanied by pictures. Correct responses were real words for part one and mostly non words for part two. This task was not administered again at T2 due to the presence of ceiling effects at T1.

Receptive Vocabulary.

Vocabulary was measured using the British Picture Vocabulary Scale, 2nd edition (Dunn, et al., 1997). Children were asked to point to one of four pictures to identify a word spoken by the experimenter. The test continued until the child made eight or more errors in a block of ten. This test was standardised in the UK for children between the ages of 3 and 15. The published reliability for this task is high, Cronbach's $\alpha = .94$ (5-6 year olds).

Home literacy environment.

Described fully in Chapter 2, p. 60 (see Appendix 1). Questions were used to provide scores for maternal and paternal education level, shared book reading at home, family literacy and age began reading to child. An additional question was added asking how many months the child had attended pre-school/ nursery. The questionnaire was returned by 44/45 parents after being sent home twice. Some parents left certain questions blank. Results of the questionnaire and reduced sample sizes are reported in Table 6.3.

6.3 Results

6.3.1 *The dynamic measure of phoneme awareness*

The suitability of the dynamic measure for measuring PA in young children with low levels of phoneme awareness was demonstrated by comparing the distribution of scores for the static and dynamic measures of PA. Figure 6.1 shows that the distribution for the dynamic measure was close to normal, while Figure 6.2 shows evidence of floor effects on the static phoneme deletion task. 24.4% of children (n = 11) scored 0-1 on phoneme deletion, 8 of whom were from the OR group, while only 2.2% of children (n = 1 from the OR) scored 0-1 on the dynamic task. This indicates that the dynamic task is more suitable than the static measures for measuring phoneme awareness skills in young children at the onset of formal reading instruction.

Figure 6.1. The distribution of dynamic phoneme segmentation scores

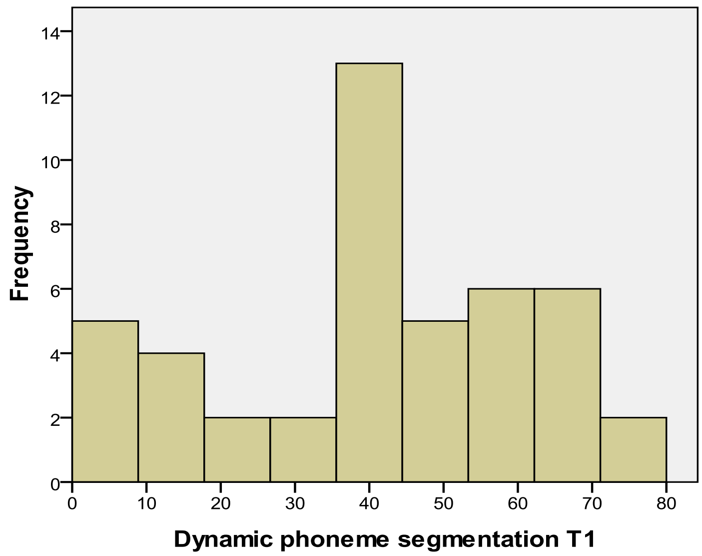
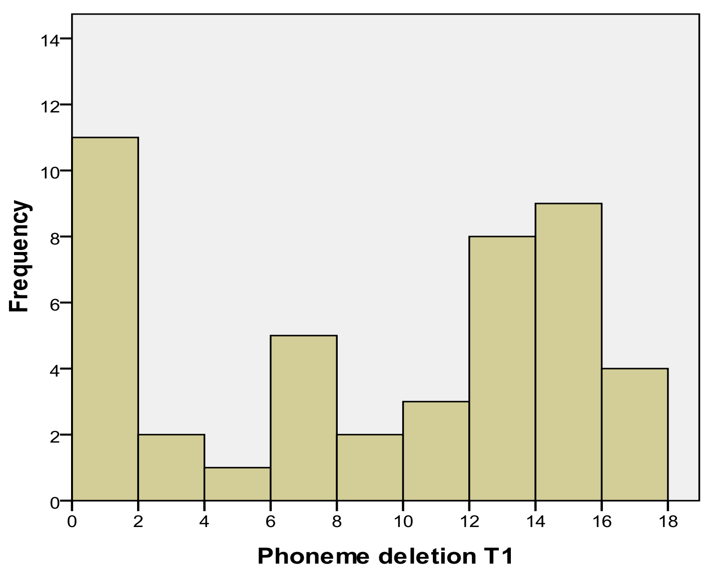


Figure 6.2. The distribution of phoneme deletion scores



Second, concurrent validity of the dynamic phoneme segmentation task is demonstrated by a high correlation with the phoneme deletion task, r = .73. It also correlated highly with measures of word reading, spelling and letter-name knowledge taken at the same time. Table 6.1 shows correlations between measures.

Table 6.1

Correlations between measures T1-2

Variable	1	2	3	4	5	6	7	8	9	10	11
Time 1											
1. Dynamic phoneme segmentation	-										
2. Phoneme deletion	.73**	-									
3. Static phoneme segmentation	.94**	.63**	-								
4. Word reading	.67**	.67**	.69**	-							
5. Letter-sound knowledge	.76**	.63**	.64**	.54**	-						
6. Letter-name knowledge	.73**	.67**	.71**	.66**	.63**	-					
Time 2											
7. Static phoneme segmentation	.66**	.46**	.65**	.32*	.39**	.28	-				
8. Word reading	.77**	.73**	.77*	.92**	.59**	.72**		-			
9. Letter-sound knowledge	.37*	.28	.33*	.18	.41**	.38**	.20		-		
10. Letter-name knowledge	.80**	.77**	.74**	.60**	.74**	.79**	.51**	.73**	.41**	-	
11. Spelling	.71**	.71**	.72**	.85**	.61**	.71**	.36*	.92**	.39**	.72**	-

Note. Correlations are bivariate (Pearson's r). Word reading at T1, Static phoneme segmentation at T2 and word reading at T2, n = 44. All other variables, n = 45.

* $p < 0.05$ (2 tailed), ** $p < 0.01$

Next, predictive validity was demonstrated by assessing the value of the dynamic compared to the static measure in the prediction of reading and spelling six months later. Due to the fact that the static phoneme segmentation score was derived from the dynamic score (number of items which required no prompts, r =.94), a comparison was not made with this task. Instead, the dynamic score was compared to the static measure of phoneme deletion. Hierarchical multiple regressions were performed entering phoneme deletion into the first step, then the dynamic measure in the second step. In order to maximize sample size, data from all three groups was combined. Table 6.2 shows the results of the regressions.

Table 6.2

Regressions predicting reading and spelling at T2 from PA at T1

Dependent variable	Reading at T2				Spelling at T2			
T1 Predictor	*B*	*SE B*	*β*	ΔR^2	*B*	*SE B*	*β*	ΔR^2
Step 1				.53**				.51**
Phoneme deletion	2.01	0.29	.73**		7.96	1.49	.71**	
Step 2				.13**				.08**
Dynamic phoneme segmentation	0.41	0.10	.51**		0.16	0.06	.41**	

Note. n =44, ** p <.01

The regressions show that the dynamic measure contributes 13% additional variance to the prediction of reading over and above the static measure and 8% additional variance to the prediction of spelling.

6.3.2 *Comparison of background characteristics between groups*

Table 6.3 shows descriptives and ANOVA results for comparisons of background characteristics between groups. The ANOVAs revealed no significant differences in important background characteristics that could influence academic achievement. There were no significant differences in standardised vocabulary, maternal and paternal education level, shared book reading at home, family literacy and age that parent began reading to their child. However, the Y1s had spent fewer months in pre-school than the ORs, $t(38) = 2.15$, $p < .05$, $r = .33$, and the O1s, $t(38) = 3.08$, $p < .01$, $r = .45$. This was because, by virtue of the month in which they were born, the older children had had more time prior to starting school during which to attend pre-school.

Table 6.3

Background characteristics

	Old Receptions	Young Year 1s	Old Year 1s	ANOVAs	
Variable	*M (SD)*	*M (SD)*	*M (SD)*	*F* (*df*)	r^2
Age at T1[a]	60.20 (0.94)	62.07 (1.01)	71.27 (0.70)	609.72 (2,42)**	.97
Age at T2	65.93 (0.88)	68.80 (1.01)	77.53 (0.74)		
Standardised Vocabulary	112.57 (12.22)	112.07 (9.95)[c]	112.20 (10.04)[c]	0.01 (2,42)	<.01
Maternal education	3.31 (1.06)	2.71 (0.83)	2.71 (0.91)	0.97 (2,40)	.05
Paternal education	3.21 (1.63)	2.71 (0.83)	3.00 (1.62)	0.45 (2,39)	.02
Shared book reading at home	42.80 (6.35)	42.71 (8.01)	45.20 (5.96)	0.64 (2,41)	.03
Family literacy	8.79 (2.08)	9.79 (2.19)	9.67 (1.35)	1.17 (2,40)	.06
Age began reading to child [a]	6.87 (5.13)	6.36 (4.73)	7.93 (4.62)	0.40 (2,41)	.02
Months in pre-school	27.86 (10.68)	18.38 (9.33)	31.93 (13.69)	4.95 (2,38)*	.21

Note. $r^2 = \frac{t^2}{t^2 + df}$, [a] in months, [c] measured one year prior when the Y1 group was age 51.93 months and the O1 group was 60.93 months. Maternal education, n = 14 (Y1), n = 14 (O1); Paternal education, n = 14 (OR), n = 14 (Y1), n =14 (O1); Shared book reading at home, n = 14 (Y1); Family literacy; n = 14 (OR), n =14 (Y1); Age began reading to child, n =14 (Y1); Months in pre-school, n = 14 (OR), n = 13 (Y1), n = 14 (O1).

*$p < .05$, ** $p < .01$

6.3.3 *Age and schooling effects on phoneme awareness*

Table 6.4 shows descriptive statistics and between-subjects ANOVA results for the phoneme awareness measures at T1 and T2. As we wished to measure phoneme deletion ability as a unitary construct, scores from the two sub-sets of the phoneme deletion task (beginning and end sounds, r =.71) were added to make a composite phoneme deletion score. Analysis of data from both phoneme segmentation tasks at T2 revealed equivalent results. Therefore, due to the higher reliability of the first task (Cronbach's α =.81, compared to .68), data from the second task are not reported.

Fourteen ANOVAs and 16 pairwise comparisons were conducted (on the phoneme awareness and early literacy measures). Therefore, adaptive linear step-up procedures were adopted to control for false discovery rate (Benjamini, et al., 2006). Twenty null hypotheses were rejected using the single linear step-up procedure at level 0.05 (overall probability of Type I error was held at p =.05). Twenty were also rejected at the first stage of the two-stage procedure run at level 0.05/1.05. At the second stage, the linear step-up procedure was used at level (0.05/1.05) × 30/ (30-20) =0.143, resulting in the rejection of 26 null hypotheses with $p \leq .093$.

Table 6.4

Phoneme awareness measures and between-groups ANOVA results

		Old Receptions	Young Year 1s	Old Year 1s	ANOVAs	
Variable	Max score	*M (SD)*	*M (SD)*	*M (SD)*	*F(2,42)*	*r²*
Dynamic phoneme segmentation T1	72	20.73 (17.07)[a]	45.40 (15.49)	56.13 (11.76)[b]	22.15**	.51
Phoneme deletion T1	16	3.73 (5.15)[a]	9.53 (5.15)	12.60 (4.32)[b]	12.72**	.38
Static phoneme segmentation T1	12	1.73 (2.34)[a]	4.73 (2.60)	6.93 (2.96)	6.20**	.23
Static phoneme segmentation T2	12	8.21 (3.77)	9.53 (1.85)	9.53 (2.30)		

Note. [a] = schooling effect, $p \leq .093$, [b] = age effect, $p \leq .093$. Word reading at T1 and T2, Static phoneme segmentation at T2, n = 14 (ORs) df = (2,41). All other variables, n = 15 (OR), n = 15 (Y1), n = 15 (O1). All means are for raw scores. Internal consistency reliabilities (alphas) are provided in the method section. Phoneme deletion = Phonological Abilities Test of Phoneme deletion (beginning and end sounds).

** $p < 0.01$

A Three-way mixed ANOVA was conducted on scores for the phoneme segmentation measure which was collected at both time points. Time was entered as a 2 level within-subjects factor and group as a three level between-subjects factor. This showed that there was a significant effect of group on the sum of scores from both time points (see table 6.4). Planned contrasts revealed here was no significant age effect (Y1s vs. O1s) $t(41)= 1.22$, $p =.23$, $r = .19$, but there was a significant schooling effect (Ors vs. Y1s) on this measure, $t(41) = 2.28$, $p <.05$, $r = .33$. There was also a main effect of time, $F(1,41)= 200.28$, $p<.01$, $r^2= .76$ and a significant group × time interaction, $F(2,41)=$

11.24, p <.01, r^2 = .09. A separate ANOVA performed on the change scores from T1 to T2 revealed that the degree of improvement exhibited by the Y1s was significantly greater than that exhibited by the O1s, $t(41)$= 2.81, p <.01, r =.40, and that the ORs made more improvement than the Y1s, $t(41)$= 1.95, p =.058, r = .29.

One-way ANOVAs were performed to look for between-group differences on the dynamic phoneme segmentation and phoneme deletion tasks performed at T1 only. These showed that there was a significant effect of group on both tasks (see table 6.4). Planned contrasts revealed that for the dynamic measure of phoneme segmentation at T1, there was a significant age, $t(42)$= 1.97, p = .056, r = .29, and schooling effect, $t(42)$= 4.52, p <.01, r = .57. For the phoneme deletion task, there was also a significant age, $t(42)$ = 1.72, p = .09, r = .26, and schooling effect, $t(42)$= 3.25, p <.01, r = .45. To summarise, there were significant age and schooling effects on the measures of phoneme deletion and dynamic phoneme segmentation and a significant schooling effect only on the static measure of phoneme segmentation.

6.3.4 *Age and schooling effects on early literacy skills*

Table 6.5 shows descriptive statistics and between-subjects ANOVA results for the early literacy measures at T1 and T2.

Table 6.5

Early literacy measures and between-groups ANOVA results

		Old Receptions	Young Year 1s	Old Year 1s	ANOVAs	
Variable	Max score	*M (SD)*	*M (SD)*	*M (SD)*	*F(2,42)*	r^2
Word reading T1	90	0.64 (0.93)[a]	13.73 (10.88)	21.60 (12.93)[b]	14.82**	.42
Word reading T2	90	12.64 (7.91)	28.60 (15.51)	36.67 (14.95)		
Letter-sound knowledge T1	26	12.20 (7.17)[a]	23.67 (2.23)	24.40 (2.77)	32.87**	.61
Letter-sound knowledge T2	26	24.53 (1.46)	24.80 (1.57)	25.20 (0.86)	-	-
Letter-name knowledge T1	26	7.07 (7.32)[a]	12.87 (7.42)	18.87 (5.03)[b]	12.41**	.37
Letter-name knowledge T2	26	13.40 (7.81)	20.00 (4.96)	22.73 (4.70)		
Spelling T2	75	9.60 (3.48)[a]	16.93 (6.86)	21.93 (7.91)[b]	14.22**	.40

Note. [a] = schooling effect, $p \leq .093$, [b] = age effect, $p \leq .093$. Word reading at T1 and T2, n = 14 (ORs) df = (2,41). All other variables, n = 15 (OR), n = 15 (Y1), n = 15 (O1). All means are for raw scores. Internal consistency reliabilities are provided in the method section. Word reading = British Ability Scales 2 word reading test; Spelling = British Ability Scales 2 spelling test.

** $p < 0.01$

Three-way mixed ANOVAs were conducted on scores for word reading and letter-name knowledge, which were measured at both time points. Improvement in letter-sound knowledge was not analysed due to ceiling effects at T2. The ANOVAs revealed that there was a significant effect of group on the sum of scores from both times points for word reading and letter-name knowledge (see table 6.5). On the word reading measure, contrasts revealed that there was a significant age, $t(41)= 1.94$, $p =.059$, $r = .29$, and schooling effect, $t(41)= 3.48$, $p < .01$, $r = .48$. There was also a significant effect of time on word reading, $F(1,41) = 184.08$, $p <.01$, $r^2 = .81$. The interaction term, group × time was not significant, $F(2,41) =.90$, $p = .41$, $r^2 = .01$. This means that all three groups made similar progress in reading between T1 and T2.

On the letter-name knowledge measure, there was a significant age $t(42) = 2.05$, $p <.05$, $r = .30$, and schooling effect, $t(42)= 2.64$, $p <.01$, $r = .38$. The effect of time was significant, $F(1,42)= 60.74$, $p <.01$, $r^2= .57$, while the interaction term group × time was non-significant, $F(2,42)= 1.76$, $p =.19$, $r^2 = .03$. This means that progress in letter-name knowledge was similar in all three groups between time points.

One-way ANOVAs were performed to look for between-group differences on the letter-sound knowledge (T1 only) and spelling (T2 only) measures. There was a significant effect of group on both tasks (see table 6.5). For letter-sound knowledge at T1, there was a non-significant age effect, $t(26.75)=0.80$, $p =.43$, $r = .15$, and a strong schooling effect, $t(16.67)= 5.91$, $p <.01$, $r =.82$. However, the lack of an age effect for this measure at T1 may be due to ceiling levels of performance in the two year 1 groups. Finally, there was a significant effect of age on spelling at T2, $t(27.45)=1.85$, $p =.08$, $r =.33$, and a highly significant schooling effect, $t(20.76)=3.69$, $p <.01$, $r =.63$. To summarise, there were significant age and schooling effects on measures of word reading, letter-name knowledge and spelling and a significant schooling effect only on letter-sound knowledge.

6.4 Discussion

This study showed that a new dynamic measure of phoneme awareness was valid and appropriate for use on young children. It was found to be a better predictor of reading and spelling six months later than a static measure and was not subject to the same floor effects. Second, age and schooling effects on phoneme awareness and early literacy skills were assessed by comparing three groups of children differing in either exposure to formal reading instruction or chronological age. There were significant age and schooling effects on almost all measures of phoneme awareness and early literacy. This suggests that, in general, older children achieve better in reading, spelling and phoneme awareness than their younger counterparts during the first 2 years of school.

Concurrent validity of the dynamic measure of PA was demonstrated through high correlations with other related variables measured at the same time. It also had predictive validity, shown by the fact that it contributed additional variance above and beyond a static measure of PA in the prediction of reading and spelling six months later. In addition, the measure had high internal reliability, indicating consistency of responses between items (Cronbach's α =.94). It was successful at eliminating floor effects for the youngest children with minimal or no reading ability (the OR group). Although static levels of PA were very low for the OR group, dynamic levels were higher, indicating that although these children could not yet read, they were able to acquire a certain level of PA if given appropriate guidance. This highlights the importance of using a suitably sensitive measure of PA on young children, to avoid reaching the potentially erroneous conclusion that they have no phoneme awareness.

It comes as no surprise that formal reading instruction in Reception and Year 1 led to significant improvements in phoneme awareness (in accordance with the alphabetic principle) (Bowey & Francis, 1991; Christian, et al., 2000; Morrison, et al., 1995), and early literacy skills (Crone & Whitehurst, 1999; Morrison, et al., 1997; Morrison, et al., 1995; Sharp, et al., 1994). The aspects of most interest are the significant age effects found on these measures, especially in light of recent concerns about the performance of summer-born children during the first years of school (Alexander, 2009; School starting age - formal teaching versus play-based learning," 2009).

The existence of an age effect on phoneme awareness during the Reception year is in contrast to findings of Bowey & Francis (1991) and Morrison et al., (1995) who found no evidence of an age effect on this skill during the first year of formal schooling in Australia and the U.S. This may be because our dynamic test of phoneme segmentation was a more sensitive measure than the oddity tasks used by Bowey & Francis, 1991 which were subject to floor effects (therefore underestimating PA in the young first graders). Also, both samples were one year older at the onset of formal schooling (5-6 years) than the current UK sample (4-5 years). The younger a child is, the larger the differences in relative age. Older Reception children can be up to 25% older than younger reception children on entry to school, a difference which may have led to larger age effects.

All groups experienced significant growth in word reading, phoneme segmentation skills and letter-name knowledge in the six months between T1 and T2. However, there were no age × experience interactions for any of the tasks. Such an interaction would have indicated faster progress for the O1 group compared to the Y1s because the older children would be expected to benefit more from the instruction that they were given. The absence of such an interaction raises the question of why the O1 group began the year with higher levels of skill than their younger classmates. In the case of phoneme awareness, it is possible that the older children entered Reception with higher levels of PA than the younger children, partly as a result of more exposure to phonologically enhancing activities such as rhyming games, music and poetry both at home and in pre-school (Fazio, 1997a, 1997b; Goswami & Bryant, 1990). This theory is supported by the fact that the older children spent longer in pre-school.

Interestingly, for the static phoneme segmentation task, the OR group experienced significantly faster growth than the Y1s and the Y1s experienced faster growth than the O1s. This suggests that the interaction was the result of different mean levels at T1. Specifically, the OR group had a lower starting level of phoneme awareness at the start of the year, and therefore more room for improvement, leading to a faster rate of progress than the Y1 and O1 group (the same logic applying to differences between the Y1 and O1 groups).

6.4.1 *Conclusions and implications*

There are currently very few assessment tools appropriate for measuring phonological awareness in children as young as 4. The dynamic measure of phoneme awareness developed for use in the current study solved many of the problems associated with previous measures (e.g., floor effects, poor predictive power), indicating that it has potential for more widespread use.

Second, given that the youngest children in Year 1 were significantly poorer at tests of early literacy and phoneme awareness, it would seem that concerns over the progress of summer-born children during the first year of school (Reception) are, to some extent, warranted. Although a causal link cannot be made, the results of the dynamic task suggest that the better reading and spelling of the O1s compared to the Y1s was due to an improved ability to learn phonological skills between the ages of 5 and 6. In turn, the better word reading and spelling of the Y1s compared to the ORs may have been due to an improved ability to learn phonological skills, developed during the Reception year. Follow-up over a longer period of time would be necessary to ascertain whether these effects persisted over time. However, current evidence suggests that age effects on academic achievement dissipate towards the end of primary school (Sharp, et al., 2009).

7 General discussion

This thesis investigates age and schooling effects on the development of reading and related skills in children between the ages of 4 and 8. Five results chapters are presented with seven key findings.

7.1 Summary of findings

In chapter 2, the effect of age on the development of reading-related skills was investigated by comparing standard-educated 4 year olds (earlier-schooled group) with Steiner-educated 7 year olds (later-schooled group). In addition, age effects were examined through comparison of the later-schooled group with standard-educated 7 year olds. The first key finding was that vocabulary and short-term verbal memory develop with age, not schooling, and that there are significant effects of both age and schooling on visual-verbal learning and phonological awareness. The second finding was that phoneme awareness can develop in pre-literate children and that there is a significant effect of age on its development. This was shown by the presence of phoneme awareness skills in two thirds of the later-schooled group and a quarter of the earlier-schooled group at the onset of formal reading instruction.

Chapter 3 examined progress in early reading and spelling skills. In this chapter, the first two groups from chapter 2 (earlier and later schooled groups) were followed at four time points during the first two years of formal schooling. The third key finding was that despite better reading-related skills, older children do not necessarily make faster progress in reading and spelling than younger children. Frequent, good ‘quality’ phonics instruction is more important than age-related factors to the development of reading, and in particular spelling.

Chapter 4 examined the effect of age and instructional method on the predictors of reading and spelling by comparing the earlier and later schooled groups followed in chapter 3. The fourth key finding was that that the predictors of literacy are similar in older and younger beginning readers and do not change spontaneously with age. However, instructional emphasis on letter sounds reduces its power as a longitudinal predictor of literacy.

In chapter 5, the nature of a possible causal link between phonological awareness, letter-sound knowledge and reading was examined using mediation analyses. Longitudinal data from the first three time points of the study were used to conduct the analyses. The fifth key finding was that for children in standard education (but not those in Steiner education), letter-sound knowledge leads to phonological awareness which in turn leads to reading. This is most likely due to the nature of synthetic phonics instruction delivered at standard schools.

In chapter 6, a dynamic measure of phoneme segmentation was developed specifically for use on young children with little or no measurable reading ability. The sixth key finding was that a dynamic measure of PA is more appropriate than a static measure for use in beginning readers; it is a better predictor of subsequent reading and spelling and is not subject to the same floor effects. Also in chapter 6, the cut–off design was employed to measure age and schooling effects on the development of phoneme awareness and early literacy skills in children exposed to the same kind of instruction. The seventh key finding was that there is a significant effect of age and schooling on the development of reading, spelling and phoneme segmentation skills during the first year of standard schooling.

7.2 Theoretical implications

Implications for current theory arise from answers to four main questions which were addressed by the present thesis. The first question asked was: what are the effects of age and schooling on phoneme awareness? Previous research has found a strong effect of schooling (first grade onwards) on the development of PA, with some evidence of an age effect during the Kindergarten year (Bentin, et al., 1991; Bowey & Francis, 1991; Morrison, et al., 1995). Chapter 2 showed that there is an effect of both age (before the onset of formal schooling) and schooling on phoneme deletion and blending skills. Similarly, in chapter 6, a significant effect of age and schooling was found on two measures of phoneme awareness during the first year of standard schooling. All in all, these studies suggest that there is an effect of age on the development of PA both prior to and during the first year of formal reading instruction.

The majority of research to date has generally found that PA does not develop in pre-literate children (e.g., Bowey & Francis, 1991; Mann, 1986). In chapter 2, there were a significant number of children who demonstrated phoneme awareness skills in the absence of measurable reading ability. This makes an important contribution to current research by showing that PA can develop in pre-readers. Activities unrelated to reading instruction such as informal language games and music were highlighted as possible causes of this development.

The second question addressed was: what is the role of age and schooling on the development of other reading-related skills? Existing research in this area is restricted to use of the cut-off design and no study has yet looked at age effects on vocabulary development (Christian, et al., 2000; Ferreira & Morrison, 1994; Morrison, et al., 1995).

In chapter 2, we found that there was a significant effect of age, not schooling on measures of vocabulary and short-term verbal memory, and an effect of age and schooling on visual-verbal learning. It was concluded that while schooling enhanced the ability to pair visual with verbal information (e.g., during letter-sound learning), the curriculum as it currently stands does not lead to advantages in the development of vocabulary and verbal memory. Significant age effects were attributed to informal experience of language during the pre-school years, both at home and at school.

The third question asked was: is there an effect of age on the development of early literacy? Existing research using the cut-off design suggests that there is an age effect on reading during the first years of school (Crone & Whitehurst, 1999; Morrison, et al., 1997). However, it is uncertain how strong this effect would be in children differing by several years in age. The study in chapter 3 is the first to investigate the role of age on early literacy development in matched samples across a three year age range. Results showed that the older group did not develop better reading than the younger group; and in fact had poorer spelling. There are two possible explanations for this result; there was no age effect or there was an age effect that was ‘cancelled out’ by instructional differences between groups.

In the conclusion, we favoured the latter view because there was evidence that the earlier-schooled group was exposed to more frequent and higher quality phonics instruction than the later-schooled group, and the amount of phonics teaching received was associated with individual progress. Therefore, we concluded that quantity and quality of phonics instruction was a stronger influence than age-related factors on the development of reading, and particularly spelling. This suggests that we would have found a significant age effect had the two groups been exposed to the same method of instruction. Our interpretation was supported by the results of chapter 6 which showed a significant effect of age on the development of reading and spelling in two ‘instruction matched’ groups. Therefore, taken together, the evidence supports the view that there *is* an effect of age on the development of early literacy skills. However, further research using instruction matched groups is needed to ascertain the size of this effect over the 4 to 7 year age range.

The fourth question addressed was: do age and different instructional methods affect *how* reading develops? There is very little research on how instruction may impact upon the skills which underlie reading development (e.g., Mann & Wimmer, 2002; Perfetti, et al., 1987). Due to the fact that the Steiner and standard methods of teaching reading differ in many ways, we were able to address this gap by comparing the later and earlier schooled groups followed in chapter 3. In chapter 4, it was found that although the predictors of reading and spelling in the Steiner (later-schooled) and standard educated (earlier-schooled) children were generally similar, there was a much stronger association between letter-sound knowledge and measures of literacy in the Steiner group. It was concluded that instructional emphasis on letter sounds in the standard group had reduced individual variation in this variable by the end of the year, therefore reducing its initial predictive power on subsequent reading.

In chapter 5, we found that there was a significant mediated pathway between letter-sound knowledge, phonological awareness and reading in the standard but not Steiner educated group. This shows that method of instruction can affect causal links between variables which are vital to the development of reading. These last two chapters highlight method of instruction as having an important influence on the way in which reading develops. Most theories of reading development assume that their view is universal; therefore the role of instruction is typically overlooked. The current research suggests that this is an overly narrow conception of how reading develops, and that future theories should take into account nature and quantity of instruction, and levels of starting skills.

7.3 Educational implications

This thesis has potential implications for educational practice in two different areas. First, as a whole, the evidence presented does not support a delay in the onset of formal reading tuition in the UK, as has been suggested by a number of education studies (Alexander, 2009; Blenkin, 1994; Fisher, 2000). There was no significant age effect found on the development of reading in chapter 3, and although there was some evidence that such an effect might have existed if quality and quantity of phonics instruction had been equal in the two groups, we cannot say this for certain. The younger children educated in standard schools responded well to the instruction that they were given and made good progress in reading and in particular spelling. Therefore, we cannot say that it is 'developmentally inappropriate' to begin teaching children how to read at the age of 4-5 (Blenkin, 1994; Fisher, 2000).

Further evidence against changing the current school starting age is provided by a comparison of age and schooling effects in chapter 6. Results showed that there was a significant age effect on the development of literacy with the oldest children in year 1 performing better on tests of reading and spelling than the youngest children in year 1. However, the effect of nine months additional age (r = .29 word reading, .33 spelling) was roughly half that of the effect of an extra year at school (*r* = .48 word reading, .63 spelling). Therefore, delaying school entry by a year would have disadvantaged children more than advantaged them in terms of their literacy achievement in the short-term. However, it may be useful to draw teachers' attention to the fact that younger children in Reception and Year 1 classes (and probably during the next few years as well), are likely to be slightly poorer readers and spellers than the oldest children, so that they may take this into account during assessments e.g., use age standardised tests.

In order to make a recommendation to delay the onset of formal reading tuition, we would need to show that this would be beneficial to literacy achievement in the long-term. There is evidence that reading ability in first grade is predictive of reading comprehension ten years later (Cunningham & Stanovich, 1997). However, we cannot be sure that the age effect demonstrated in chapter 6 does not dissipate over time. Indeed, there is evidence that relative age effects (within a year group) are no longer present by the end of primary school (Sharp, et al., 2009). Longitudinal follow-up over the next 5-10 years would be needed to determine whether the age effect in chapter 6 persisted in the long-run.

The second educational implication relates to the Steiner teaching method. In chapter 3, it was discovered that there were a significant number (33%) of Steiner-educated children who could not read simple words by the end of the first year of instruction. It was also found that their improvement in blending skills, letter-sound knowledge and spelling were significantly poorer than that of younger children taught via the synthetic phonics method. These findings raise concerns about the impact of the Steiner method for teaching reading, particularly for children who may be at risk of reading difficulties. Although our data on the nature and frequency of literacy instruction is limited (based on a brief teacher's questionnaire), we were able to ascertain that the Steiner group were exposed to substantially less phonics instruction during the first year of formal teaching than their standard-educated counterparts (mainly due to the 'block' system resulting in less weeks of active instruction). The implication is that Steiner children would benefit from more frequent phonics instruction. Also, in line with the conclusions of Bus and Kruizenga, (1986) our results suggest that it would be beneficial for Steiner children to receive more specific instruction in letter-sound knowledge and phonological synthesis.

7.4 Possible limitations

Chapters 2 – 5 compare Steiner-educated children with standard-educated children in order to reach conclusions about the effect of age on reading development. While every effort was made to match groups as closely as possible on background variables, there were still cultural and environmental differences which could not be controlled for. Parents who send their children to Steiner schools make a conscious choice in favour of the Steiner philosophy and become part of a close-knit Steiner community (Steiner, 1924/1982). Consequently, they are more likely to adhere to 'Steinerised' activities in the home as well e.g., healthy eating, plenty of outdoor activity, limited exposure to media and television (Rawson & Richter, 2000). As Steiner schools in the UK are fee-paying, parents of the Steiner group were also better-educated, indicating higher SES than the standard-educated group.

A healthy home environment, in addition to the unique nature of the Steiner Kindergarten curriculum (lots of music, poetry and story-telling) may have led to an enhancement of the age effects observed in chapters 2 and 3 (compared to children from similar backgrounds to the standard-educated group). However, three things lead us to be more confident about the generalisablity of our findings: a) the Steiner sample demonstrated average vocabulary levels for their age, b) questionnaires to parents of both groups revealed similar levels of family literacy, shared book reading and age at which they began reading to their child, and c) maternal education level was not significantly associated with the variables tested.

In a similar vein, it is possible that the later-schooled group had better reading-related skills than the earlier-schooled group in chapter 2 because they had better reading skills. The mean number of words read at T1 was higher in the later-schooled (1.03) compared to the earlier-schooled group (0.52). However, two things make us confident that this was not a particular issue in the current thesis; a) re-analyses of data with word reading as a covariate yielded virtually identical results to analyses without the covariate, and b) the later-schooled children had poorer letter-sound knowledge at T1 than the earlier-schooled group suggesting that they did not have better overall literacy skills.

Finally, sample sizes in the current thesis were quite small, n = 30 per group in chapters 2-5 and n =15 per group in chapter 6. Therefore, there will have been a relatively high chance of Type II error occurring (finding no significant effect when there is one) due to low power (Cohen, 1988). However, three things lead us to be confident in the non-significant findings that we found a) the use of linear step-up procedures in chapters 2 and 6 led to an increase in power, b) effect sizes, r or r^2, were reported for all analyses and near-significant results e.g., p = .07 were commented upon in the conclusions, and c) the present sample sizes are not unusual in developmental research, particularly in studies which use the cut-off design e.g., 10 per group (Morrison, et al., 1995), and 20 per group (Bowey & Francis, 1991).

Finally, the current research shows the effect of age on the development of reading and related skills, however, it can only speculate on the *mechanisms* behind these effects. It is likely that two factors drove the age effects found in the present thesis: ‘natural’ cognitive maturation and informal experience of language. However, further research is needed to determine which of these factors contributes most to the development of different skills and how the effect operates.

7.5 Conclusions

This thesis makes an important contribution to research on reading development by highlighting the significant role of age and instruction on the development of early literacy and related skills. It advances knowledge in the area by showing that a) there is an effect of age on the development of phoneme awareness during pre-school and the first year of formal reading instruction and that PA can develop in pre-readers, b) vocabulary and short-term verbal memory develop significantly between the ages of 4 and 7, and are not enhanced by exposure to formal schooling, c) there is an effect of age on the development of early literacy skills, but (it is suggested) quantity and quality of phonics instruction has a stronger effect on progress, and d) method of reading instruction can affect the relationship between letter-sound knowledge, phonological awareness and reading. The evidence presented in this thesis suggests that concerns that age 4-5 is too early to learn to read are unfounded, and that a delay in school entry age will not necessarily lead to benefits in the acquisition of reading.

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Appendix 1

Home Literacy Environment Questionnaire

1. About how many children's picture books do you own? (please circle one)
   - a. 0 to 2
   - b. 3 to 10
   - c. 11 to 20
   - d. 21 to 40
   - e. 41 to 60
   - f. 61 to 100
   - g. 101 to 150
   - h. 151 to 200
   - i. 200 or more

2. About how often do you read a book with your child? (please circle one)
   - a. Hardly ever
   - b. Once or twice a month
   - c. Once or twice a week
   - d. Three times a week
   - e. Four times a week
   - f. Five times a week
   - g. Every day

3. At what age in months did you begin to read to your child? ________________ Months*

4. About how often does reading occur at bedtime?
   - a. Hardly ever
   - b. Once or twice a month
   - c. Once or twice a week
   - d. Three times a week
   - e. Four times a week
   - f. Five times a week
   - g. Every day

5. What percentage of the time do you read more than one book during reading? _______ %

6. What percentage of the time does reading end because your child loses interest? _____________ %

7. About how may times per week is your child read to by other people in the home?
   - a. Hardly ever
   - b. Once or twice a month
   - c. Once or twice a week
   - d. Three times a week
   - e. Four times a week
   - f. Five times a week
   - g. Every day

8. If your child is read to by you or others in the home, how much does he or she enjoy it?
   - a. A little
   - c. Very much
   - b. Pretty much
   - d. Loves it

9. About how many times per week does your child ask to be read to?

a. Hardly ever
b. Once or twice a month
c. Once or twice a week
d. Three times a week
e. Four times a week
f. Five times a week
g. Every day

10. About how many times per week does your child look at books by himself or herself?

a. Hardly ever
b. Once or twice a month
c. Once or twice a week
d. Three times a week
e. Four times a week
f. Five times a week
g. Every day

11. About how many times per month do you go to the library with your child?*

a. Hardly ever
b. Once or twice a month
c. Once or twice a week
d. Three times a week
e. Four times a week
f. Five times a week
g. Every day

12. Has your child been in any library or reading programs? YES / NO (please circle one)*

13. How many years of schooling have you completed?*

a. left school with no formal qualifications
b. O levels/ GCSEs
c. A levels or equivalent
d. 3 year University degree
e. 4 year University degree
f. some postgraduate study
g. Masters degree
h. Ph.D

14. How many years of schooling has your spouse/ significant other completed?*

a. left school with no formal qualifications
b. O levels/ GCSEs
c. A levels or equivalent
d. 3 year University degree
e. 4 year University degree
f. some postgraduate study
g. Masters degree
h. Ph.D

15. How many hours per day does your child watch T.V.?*

Monday to Friday: ____________________________
Saturday: ____________________________
Sunday: ____________________________

16. Does your family subscribe to any newspapers or magazines? YES / NO (please circle one)*

17. How often does mother read to herself?*
    a. weekly or less
    b. several times a week
    c. daily

18. How often does father read to himself?*
    a. weekly or less
    b. several times a week
    c. daily

Note. * question included for earlier-schooled age matched controls

Questions coded a – i, a-g, a-d or a-c were assigned one point per letter (a = 1, i =9) apart from parental education level where d and e were both assigned 4 points.

Questions measured in percentages were scored on a four-point scale (1= 75-100% to 4 =0-25%). Yes/No questions were scored 1/0. Number of hours of television was totalled for the week and scored on a 3-point scale (3= 0-15, 1 = 26+ hours).

Shared book reading at home = Total for Qs 1-10 (exc. 3).

Family literacy = Total for Qs 11, 12, 15, 16, 17, and 18.

Appendix 2

Teacher Questionnaire

1. Approximately how much time is allocated to any kind of reading activity (whether small group, individual or class) per week?
2. Approximately how much time is allocated to each separate reading session? (i.e. how long to you spend on a single reading session, all in one go, before you move on to a new topic?)

   15 minutes or less   Between 15-30 minutes

   Between 30-45 minutes   Over 45 minutes

   If the timing of each reading session varies according to the activity, please provide details below:
3. How many ‘reading’ sessions do you have on average per week?
4. On average, how often do you engage in the following reading-related activities this academic year?

	Daily	Weekly	Half-Termly	Rarely
Phonic work				
Sight vocabulary (learning whole words)				

5. Have the children in your class been exposed to any ‘formal reading instruction’ prior to this academic year (Class 2)? e.g. letter learning. Please provide details below.

6. How would you describe your method of teaching reading? For example, do you use a ‘mixed’ method of teaching phonics and whole words or is the focus more on one than the other?

Note. Together with information gathered from informal discussions with teachers, responses to question 1 of the questionnaire were used to help calculate. Responses to questions 2 and 4 were used to calculate the number of hours spent on phonic work in each class per week. Number of weeks of active instruction during the 8 months between T1 and T3 was calculated taking into account school holidays and the teaching block system followed by Steiner schools.

Appendix 3

Dynamic segmentation task

Introductory instructions

'Now we're going to play a word game with nonsense words. I'm going to say a nonsense word and ask you to break it apart. You have to tell me each sound that you *hear* in the word. For example, when I say 'toff', you say 't-o-ff'. When I say 'shun', you say 'sh-u-n'. Remember, I want you to tell me the sounds in the words, not how to spell them. Sometimes, they are the same. For example, the 'ee' in 'Lee' has two letters but is one sound.

General procedure

If a child is unable to segment a word correctly on the first try, move them through the prompts (in order) until they produce the correct answer (each phoneme in the word pronounced separately). After the correct segmentation is achieved, move onto the next item. Discontinue the test after 4 consecutive scores of zero (failure to segment after all seven prompts). For the first two items, precede word with 'what are the sounds in?'.If child fails to segment after all prompts, give corrective feedback on first 3 items only. Repeat each word up to two times if necessary. If a child gives a spelling as a response e.g., 's-h' for 'sh', remind them that you want to know the *sounds* in the words, not the way they are spelt.

Prompts

Prompt 1: 'Listen while I say the word very slowly.' Model slow pronunciation.

'Now can you tell me each sound?'

Prompt 2: 'What's the first sound you hear in ....?'

If child still does not isolate first sound, skip Prompts 3 and 4. Go to Prompt 5.

If the first sound is correct: 'Now can you tell me each of the next sounds?'

If incorrect or no response: 'Try to tell me just a little bit of the word.'

Prompt 3: If child correctly identified first sound but not next sound(s):

'....is the first sound in ....'

'What sound comes next?'

'Now can you tell me each sound?'

Prompt 4: 'There are (give number of phonemes) sounds in .... What are they?'

Prompt 5: 'Watch me'. Model segmentation of word: Place a wooden cube in front of the child as each sound is spoken, then repeat the word as a whole. Then say: 'Try to do what I just did.'

Prompt 6: 'Let's try together'. Model segmentation of word with child. Work hand-over-hand with child and ask them to pronounce phonemes with you.

'Now try to do it yourself. Do what we just did together.'

Prompt 7: Repeat Prompt 6.

Scores

6= correct response with no prompts required; 5 =correct response after Prompt 1; 4 =correct response after Prompt 2; 3= correct response after Prompt 3; 2 =correct response after Prompt 4; 1 =correct response after prompt 5, 6 or 7; and 0 =no correct response

Words in dynamic and static phoneme segmentation tasks:

Og, pim, ab, nud, dar, hish, dreet, chee, shreb, veng, grint, glorpid

Words in second static segmentation task (T2):

ez, fee, rop, shar, guth, ib, sal, thraf, zonk, skung, staip, flirmab